ESSAYS ON TRADE POLICY IN THE PRESENCE OF ASYMMETRIC INFORMATION: AN INCENTIVE COMPATIBLE APPROACH

By

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To my parents, wife and children

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Abstract of Dissertation Presented to the Graduate School
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ESSAYS ON TRADE POLICY IN THE PRESENCE OF ASYMMETRIC INFORMATION: AN INCENTIVE COMPATIBLE APPROACH

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The three essays in this dissertation consider the effects of incomplete information on trade policies when a country faces a foreign firm with market power. The first two essays deal with the problem of optimal foreign rent-extraction tariffs under incomplete cost and demand information, respectively. In Chapter 2, it is shown that the optimal tariffs are higher when the policy maker has incomplete information about the foreign firm's costs. It is also shown that with a highly convex demand structure, the optimal intervention instrument is ambiguous. Chapter 3 considers the case where a national government is uncertain about its local demand conditions. Here the optimal tariffs reflecting informational asymmetries exceed their full-information counterparts, except at the highest demand level. It is found that the policy implications of these new tariffs under incomplete demand information are analogous to those in the case of asymmetric

cost information. This fact implies that under incomplete information, the optimal tariff policy is invariant to the source of uncertainty. The properties that any incentive compatible tariff schedule must have will also be presented in Chapters 2 and 3, respectively.

The last essay deals with the problem of designing an optimal policy for the regulation of dumping. The focus is on how an importing nation should design its anti-dumping policy to increase social welfare. The welfare effects of anti-dumping policies are examined in the first part of Chapter 4. It is shown that welfare will deteriorate under an anti-dumping policy. In the second part, under the assumption of incomplete information, the incentive compatible regulatory policy is designed and its policy implications are investigated. Along with the properly designed price-transfer schedules, anti-dumping restrictions serve to discourage unduly low pricing by the foreign firm. It is also shown that the optimal regulation policy has the effect of correcting the pre-existing anti-dumping tariff distortion.

CHAPTER 1
INTRODUCTION

This chapter provides a primer to the subsequent three essays. The three essays in this dissertation deal with the optimal trade policies in the presence of incomplete information.

It is a well-known fact that traditional models on international trade are based on strong assumptions that technology is characterized by constant returns to scale and that markets are perfectly competitive. Under these assumptions the traditional trade theories consider international trade as being caused by differences in tastes, technology and relative factor endowments between countries. For instance, technological differences is the cause of international trade in the Ricardian trade model. The Heckscher-Ohlin-Samuelson trade theory emphasizes on the difference in relative factor endowments (See Caves and Jones (1985) for a summary of the traditional trade theories).

Traditional trade theory, however, cannot explain well some important phenomena in international trade: for example, intra-industry trade in similar products or trade between similar countries with regard to tastes, technology and relative factor endowments. Therefore traditional trade theory has been facing new challenges not only in practice but also in theory. In the theoretical literature, increased discontent with the unrealistic assumptions has propelled economists to look for new approaches to trade theory and to re-examine the robustness of the doctrine of free trade, long endorsed by the traditional trade theory. Many economists have become increasingly aware of the importance of imperfect competition and increasing returns to scale in many of the more heavily protected manufacturing industries (e.g., steel and automobiles). However, most of these perceptions were not expressed formally until the late 1970s and early 1980s when a series of important papers by trade theorists subjected the full range of non-competitive market structures to formal analysis. In the process, many ideas from industrial organization theory permeated the trade literature, and a range of new arguments for and against protection were given prominence. Among other things, Krugman (1979), Dixit and Norman (1980), and Lancaster (1980) establish that international trade can be caused by increasing returns to scale, using a trade model in which market structure is characterized by monopolistic competition. Brander (1981), Brander and Krugman (1983) and Dixit (1984) also develop a trade model in which the rivalry of firms in a Cournot-Nash oligopoly functions as a independent cause of international trade. It is shown that the oligopolistic rivalry of firms can result in two-way trade in identical products. Increasing returns to scale and imperfect competition have come to be recognized as important causes of international trade (For a survey, in particular, see Helpman and Krugman (1985,1989) and Baldwin (1992)).

The new theories of international trade shed light on the possibility that strategic trade policy improves national welfare. In the last few years, there has been intensive theoretical research in the area of strategic trade policy. Major recent contributions to the theory of trade policy under imperfectly competitive market conditions include Brander and Spencer (1981, 1984, 1985), Dixit (1984), Krugman (1984), Eaton and Grossman (1986), and Helpman and Krugman (1985, 1989; Introduction). They characterized the imperfectly competitive market framework as the new trade theory. Brander and Spencer (1985), for example, consider a Cournot-Nash duopoly model where a domestic firm and a foreign firm compete in a market of the third country. They show that the domestic export subsidy can increase national welfare of the domestic country by helping the domestic firm capture a large share of the market. Their research provides a new theoretical justification for export subsidies, based on the presence of imperfect competition. Subsequent papers (e.g., Eaton-Grossman (1986), Horstmann-Markusen (1986), Neary (1991)) have extended this line of research to allow for price competition, an arbitrary number of home and foreign firms, an opportunity cost of public funds, and different timing of the game. From the perspective of the importing country, on the other hand, protective tariffs are found to increase national welfare of the importing country by extracting some portion of economic rents earned by foreign supplier (Katrak (1977), Svedverg (1979), and Brander and Spencer (1984a,b)). This case will be discussed further in Chapters 2 and 3.

Although many models on the strategic trade policy have been constructed in terms of more realistic assumptions, they have not departed completely from the strong and implicit assumptions of traditional theory of trade. Perhaps the most damaging criticism may be raised against the assumption that a national government has complete information necessary to implement its optimal policy. Little effort has been made so far to examine implications of incomplete information on trade policy. As we know well, incomplete information is very common in international markets. For example, the adverse-selection problem arises naturally. This corresponds to the inability of policy makers to observe the foreign firms' private information, such as technologies or market conditions.

In the light of this attention, the next step for the strategic trade policy is to incorporate the national government's informational constraints explicitly in the model. This is the motivation of this dissertation. I try to extend the existing literature by showing that informational asymmetries play a crucial role in designing appropriate trade policies. In three essays the general question we ask is: What is the impact of informational asymmetries on the trade policies?

To construct the relevant problems, we introduce the more modern concept of incentive compatibility in the models. The justification for incentive-compatibility condition is known as the "Revelation Principle" (For useful exposition, see Myerson (1979), Dasgupta, Hammond and Maskin (1979) and Harris and Townsend (1981)). The Revelation Principle states that under some reasonable assumptions, any given resource-allocation process can be described by a mechanism in which the participants are simply asked to reveal their private information, with the payoffs designed so that each individual finds it in his or her interest to tell the truth. The Revelation Principle has made possible the solution of a wide range of problems in which relevant information is dispersed among several economic agents. The value of the Revelation Principle is that it reduces a complicated economic problem to a straightforward mathematical-programming problem. An objective function is to be maximized subject to two kinds of constraints: *individual-rationality* constraints, which recognize that any individual is free to choose not to participate in the mechanism; and *incentive-compatibility* constraints, which ensure that each individual's payoffs are such that he is rewarded for revealing his private information truthfully. Put it differently, the incentive-compatibility problem is usually solved by imposing truth-telling constraints on the set of feasible arrangements between the two parties. The truth-telling constraints will, if binding, constrain the set of allocations which can be achieved.

Chapters 2 and 3 deal with a country's optimal tariff policy towards a foreign monopolist in the presence of incomplete information. When trade policies are applied against the foreign firms with market power there is a real possibility that the importing country may gain -- in effect, that it can use trade policy to recapture some of the monopoly rents these foreign firms are extracting from domestic consumers. This idea was first analyzed by Katrak (1977). He and Svedverg (1979) showed that a positive import tax raises the welfare of the importing country in a partial equilibrium model with linear import demand and constant marginal costs for the foreign monopolist. Brander and Spencer (1984a,b) relaxed the assumption of linear demand, and showed that (i) with specific tariffs or subsidies, a subsidy is optimal if demand is sufficiently convex, otherwise a tariff is optimal; (ii) with ad valorem tariffs or subsidies, the change in elasticity along the demand curve is used to determine whether a tariff or subsidy is welfare improving. If demand elasticity is decreasing (increasing) then a tariff (subsidy) improves welfare. Jones (1987) demonstrated that this ambiguity is preserved when import demand includes income effects. The argument for a tariff as a means of capturing foreign rents for the domestic taxpayers is, in particular, interesting because it is a rare instance of a small country being able to gain by using a tariff.[1]

Although the existing models provide significant insight, they do not tackle the crucial problem of imperfect information. In the first two essays, therefore, we try to generalize the elegant and influential results by Brander and Spencer (1984a,b) by invoking the problem of incomplete information. Before attempting to draw any general conclusions about appropriate trade policy in the presence of incomplete information, it is imperative that the nature of the information asymmetry be carefully identified. Thus, we consider different types of uncertainty in Chapters 2 and 3, respectively. Chapter 2 deals with the optimal (tariff) policy problem when the domestic government is uncertain about the foreign monopolist's costs, while Chapter 3 considers the case where the domestic government is uncertain about its local demand conditions. These two analyses show that the policy implications in the presence of incomplete information are invariant to the source of uncertainty. The only difference between two cases is the magnitude of the optimal tariffs which depends on the cost or demand parameter, respectively. Under incomplete information, the socially desired tariff levels must be adjusted upwards to reflect the informational asymmetries, so that they are higher than full-information counterparts (Brander and Spencer's results). Brander and Spencer's conclusion that if demand is not too convex, then the optimal policy instrument is tariff holds even under incomplete information. With too convex demand structure and informational asymmetries, however, the sign of the optimal intervention instrument is ambiguous; this implies that free trade and tariff as well as subsidy are all possible instruments, depending on the values of unknown parameters. This is in contrast with Brander and Spencer's single result. The differing properties of incentive compatible tariff schedules, depending on the informational parameters under consideration, are also shown in Chapters 2 and 3, respectively. In summary, the broader conclusion, common to both chapters, is that informational asymmetries play a crucial role in designing the optimal tariff policy. Therefore, a government which fails to recognize that it is limited in its information will find its tariff will not achieve the desired outcome.

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[1] However, a tariff is not always the first-best policy instrument, given that the primary objective is to capture foreign profits. Katrak(1977) found also that a consumption tax welfare-dominates the optimum tariff while DeMeza(1979) demonstrated that a price ceiling equal to the foreign monopolist's constant marginal costs is even better. More recently, Helpman and Krugman(1989) surveyed existing policies and analyzed a new instrument, the "minimum import requirement," which, through a quantity announcement, obtains a larger volume of imports at a better price (See their book, Chapter 4).

Chapter 4 deals with both the welfare effect of anti-dumping laws and the problem of designing an optimal policy for the regulation of dumping. Somewhat surprisingly, nearly all the literature on dumping seems to be very restricted in scope; i.e., they have mainly focused on the question of why exporting firms dump in foreign markets. For example, recent models such as Ethier (1982), Davies and McGuiness (1982), Bernhardt (1984), Blair and Cheng (1984) and Hillman and Katz (1986) have focused on uncertainty as an underlying reason for the dumping of goods in foreign markets below marginal cost of production. Relatively little attention has been paid to the optimal regulation of the foreign (exporting) firms by the importing nation. Although recently several models (Leidy and Hoekman (1990), Staiger and Wolak (1992), Webb (1992), Fischer (1992) and

Reitzes (1993)) have examined the impact of anti-dumping laws, they do not analyze the optimal regulatory policy against foreign dumping in terms of an importing nation. For comparison with the existing literature, we first analyze the effect of anti-dumping policy on welfare under complete information. It is then shown that welfare will deteriorate in a quantity-setting Stackelberg model. In the existing literature above, in fact, the effects of anti-dumping laws on welfare are mixed, depending largely on the assumption of competition type between firms. Then a natural question to ask is on the optimal dumping-regulation mechanism. That is, we would like to know the question of how an importing nation should design its anti-dumping policy to increase social welfare, especially in the presence of incomplete information. The second part of Chapter 4 takes a modest first step towards this issue.

As a practical matter, many foreign firms accused of dumping complain against such unfair measures or the charged dumping margin and appeal to the GATT or the investigating authority for relief. This fact implies that the dumping issue may fundamentally be the problem of asymmetric information. The regulatory mechanism offered in the paper is constructed within a general revelation approach. The main implications are as follows: (i) By designing the price and transfer schedules properly, the government of the importing country can guide the foreign firm to truthfully reveal its private information, cost parameters. (ii) Then anti-dumping restriction will greatly serve to discourage unduly low pricing by the foreign firm. This suggests that the attention given to the negative effects of anti-dumping laws was probably misplaced. (iii) The optimal regulatory policy corrects for the pre-existing anti-dumping tariff distortion in that the national government transfers any tariff revenues back to the foreign firm. This implies that the government must undo the effects of the pre-existing tariff distortions in order to make allocation decisions based on true costs.

Finally, the broader insight we can draw from the analyses of three essays will be briefly pointed out in Chapter 5.

CHAPTER 2
EXTRACTING FOREIGN-MONOPOLY RENTS IN THE PRESENCE OF ASYMMETRIC COST INFORMATION

2.1 Introduction

This chapter addresses the trade policy problem when a nation (referred to as the domestic country) faces a foreign firm with market power. We here suppose that there is no domestic production of the good, and the domestic market is supplied entirely by the foreign monopolist who repatriates any profits earned. In the past, much of Europe's trade was undertaken by trading houses who had been granted monopoly status by government decrees. More recently, it has been proposed that OPEC acts as a rent-maximizing cartel. Also, it seems that the multinational enterprises (MNEs) have, in many cases, monopoly power in international markets.

There exist two strands in the literature on strategic trade policy pertaining to the regulation of the foreign firm. One has been developed in terms of transfer pricing of MNEs. Starting with the influential papers by Horst (1971) and Copithorne (1971), a number of economists have studied the effect of various tax/tariff regimes on the pricing and production decisions of MNEs and, conversely, the optimal regime for regulating the profit-maximizing MNE.[1]

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[1] See the useful survey paper by Eden(1985) for a introduction to this literature. The other papers collected in Rugman and Eden(1985) provide theoretical extensions and empirical observations on the phenomenon of transfer pricing and its regulation. Among others, Diewert(1985) derives optimal transfer price regulation in a very general

The other strand has been developed in terms of a country's optimal tariff policy on imports from the foreign monopolist. It has been recognized from the traditional tariff theory that barring externalities or distortions which support second-best arguments for commercial policy intervention, a small open economy's tariff rate is zero. As we know well, however, the theory of commercial policy has been undergoing substantial changes as the policy properties of trade models of imperfect competition has been investigated.[2] The above conventional prescription may be altered if a country faces a foreign monopolist. Several authors have showed that a country can gain by using a tariff as a means of extracting foreign-monopoly rents. Such a situation is possible when the benefits derived from revenue are larger than negative effect on quantity of imports. These models may be viewed as an extension of the traditional optimal tariff theory. Katrak (1977) and Svedberg (1979) showed, using linear demand for the import good and constant marginal cost for the monopolist, that a tariff can be used to extract rent from a foreign monopoly. Brander and Spencer (1981) also examined the use of a tariff in the case in which potential domestic entrants may be deterred from entering by a foreign monopolist. Subsequently, Brander and Spencer (1984a,b) relaxed the assumption of linear demand, and showed that not only does the order of magnitude of the optimal tariff depend upon parameter values of the model, but so does the sign of the optimal intervention. If the

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framework. Prusa's paper(1990) offers an incentive compatible approach for optimally regulating certain types of transfer pricing in vertically integrated MNEs.

[2] This discussion is quite nicely surveyed (and extended) in Helpman and Krugman(1989) or Baldwin(1992).

elasticity of import demand increases in consumption, the optimal policy involves an *ad valorem* subsidy, while the optimal policy is a *specific* subsidy if import demand is "very convex." Indeed there are demand functions with the property that if a rate is ad valorem the optimal policy is a tariff, while if the policy is specific a subsidy is called for. Jones (1987) demonstrates that this ambiguity holds in general equilibrium as well. Bergstrom (1982) considers the noncooperative tariff response to OPEC by consuming nations.

Although the existing models on the optimal tariff policy were nicely analyzed, a shortcoming is that they have utilized the assumption of full information. That is, it was assumed that a national government possesses a complete information necessary to implement its optimal policy. In this chapter, therefore, we relax the full information assumption in order to deal with the problem of optimal tariff policy against the foreign monopolist from the domestic country's welfare standpoint. Throughout the chapter we will assume that the foreign monopolist has more information about its costs than the domestic government does. Then foreign monopolist might be tempted to overstate its true costs to obtain a higher price and thereby a higher profit. In such a situation, it seems compelling to consider explicitly the domestic government's informational constraints in the analysis of tariff policy issues.

It is shown that the effectiveness of the domestic government's trade policy is impaired by its limited information about the foreign firm's cost parameters; and that the socially desired tariff level must be higher than the counterpart under complete information. The tariff scheme we propose in this chapter is a nonlinear scheme in which the tariff is contingent on the foreign monopolist's true cost parameters. Under such a tariff scheme the domestic government can extract additional foreign rents caused by the informational asymmetries between the domestic government and the foreign monopolist.

Finally, note that in our analysis, only the foreign monopolist and the domestic government are the decision makers. The foreign (or source) country has no role in our analysis other than that of location of the foreign monopolist's shareholders who ultimately receive the monopolist's after-tax profits.

The analysis proceeds as follows. We specify the main ingredients of the model in the next section. Section 2.3 characterizes the optimum specific and ad valorem tariff, respectively, in the presence of asymmetric information. Concluding remarks appear in section 2.4.

2.2 Elements of the Model

The domestic government (hereafter DG) and the foreign monopolist (FM) are two main players in the model we analyze. Suppose that a particular good is not produced domestically at all but is supplied from abroad by a FM. Under this situation, the domestic demand for imports can simply be expressed as a downward-sloping demand curve whose elasticity determines the monopolist's monopoly power.

Even though the domestic market for a good is supplied entirely by a FM, the DG have no jurisdiction over the FM's operation except that it could impose tariffs on the imported good. The natural candidate for a policy instrument is thus a tariff.[3] Tariffs can transfer foreign rents to the domestic treasury in the form of tariff revenue. There is, of course, some cost in that markets are further distorted, but it is clear that, from a purely domestic point of view, specific/or ad valorem tariffs are likely to be attractive tools to extract rents. In practice, the argument for a tariff as a means of capturing rents from a single-product FM for the domestic taxpayer is interesting because it is a rare instance of a small country being able to gain by using a tariff.

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[3] Given that the primary objective is to capture foreign profits, the first-best policy would be a profit tax (For a relevant literature, see footnote 1 in Chapter 1). However, governments are often severely constrained in their use of such taxes because of the need

2.2.1 Cost Function

The first ingredient in the model is a cost representation of the FM. The cost to the FM of producing output q when his cost parameter is θ is

$$C = c(q,\theta) \tag{2.1}$$

This cost function (2.1) is general enough to include, as special case, the case of unknown marginal costs ($C(q,\theta) = \theta q+k$, k is a fixed cost).[4] Asymmetric information is now introduced through the cost parameter θ of the monopolist. A simple way to capture the

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to keep their rates roughly in line with those of similar countries (otherwise they risk being impoverished by international tax arbitrage)[See Caves(1982) for a detailed discussion of tax regimes]. For this reason, a tariff may not be a bad policy, not least because it can be precisely applied to specific goods or industries. In other context, the (small) domestic government may impose a high tariff (called by Svedverg(1979) the *switchover tariff*) on a monopolistic supplier to induce him to engage in subsidiary production in domestic market. That is, the foreign monopolist could circumvent the tariff by ceasing to export from its home base and instead establish a subsidiary in the domestic country. This is the *tariff jumping* idea in the theory of foreign direct investment (See Caves(1982), Brander and Spencer(1987) and Motta(1992)).

[4] Although we specify non-constant cost function, it can be handled easily in the model by assuming that the FM sells only in the domestic market. If the FM ia able to discriminate among markets and maximize profit in each country separately, its choice in different markets might be connected through the dependence of marginal cost on total output. Then this complication can be eliminated only by assuming that marginal cost is constant in the range of output under consideration.

informational asymmetry between the FM and the DG is to assume that the distribution of θ is common knowledge but that the particular realization of θ is known only to the FM. We shall assume that θ ranges in the interval $[\theta_0,\theta_1]$, $\theta_1>\theta_0>0$, with density $f(\theta) = F'(\theta)$. In what follows we will also assume that $F(\theta)$ has the monotone hazard rate property (MHRP), $d/d\theta[F(\theta)/f(\theta)] \geq 0$, for all θ.[5]

We make the further assumptions regarding the FM's costs.

Assumptions:

(A.1) $c_\theta(q,\theta) > 0$, for all q,θ,

(A.2) $c_{q\theta}(q,\theta) > 0$,for all q,θ,

(A.3) $c_q(q,\theta) > 0$, for all q,θ,

(A.4) $c_{qq}(q,\theta) > 0$,for all q,θ,

(A.5) $c_{qq\theta}(q,\theta) > 0$,for all q,θ,

(A.6) $c_{q\theta\theta}(q,\theta) > 0$,for all q,θ.

where subscripts denote partial derivatives (here and throughout).

(A.1) states that cost is increasing in θ. The higher θ the more inefficient is the FM. (A.2) is common in the mechanism design models where it is known as "single crossing" property. It states that marginal cost is also increasing in θ. According to (A.3) and (A.4), for all cost parameters, the monopolist's marginal production costs increase with output at an increasing rate. (A.5) states that the marginal cost curve is steeper for inefficient case than for efficient one. (A.6) requires that marginal cost not only rises with θ but increases faster the higher θ. (A.5) and (A.6) guarantee that the socially optimal output decreases with θ.

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[5] This is a familiar condition in models involving private information. This property is invoked to eliminate the possibility of pooling equilibria arising, which would technically complicate the analysis. There are many density functions satisfying this condition - including the uniform, normal, exponential, and other frequently used distributions.

2.2.2 Demand Function

The domestic demand function for the FM's product is assumed to be known by both parties. The demand conditions are also assumed to arise from a utility function that can be approximated by the form

$$U = u(q) + m \tag{2.2}$$

where m is expenditure on other goods. We also assume that $u'>0$ and $u''<0$. Since this utility function implies that the marginal utility of income equals 1, inverse demand is just the derivative of u and satisfies the following, when the FM reports that its cost parameter is $\hat{\theta}$

$$\begin{aligned} p(\hat{\theta}) &= u'(q(\hat{\theta})) \\ &\equiv P(q(\hat{\theta})) \end{aligned} \tag{2.3}$$

Consumer surplus (CS) then is

$$u(q) - p \cdot q \tag{2.4}$$

where $u(q)\,(=\int_0^q p(\tilde{q})d\tilde{q})$ is the total willingness to pay by consumers.

2.3 Derivation of the Optimal Tariff Function

In this section we consider the design of the welfare-maximization tariff policy under incomplete information. As specified in (2.1), the cost function depends on the quantity produced q and on a cost report $\hat{\theta}$ from the FM to the DG, which may differ from the true cost parameter θ. The incentive problem, thus, arises from the fact that the FM will choose q strategically to its advantage. Then the DG uses its tariff policy to affect rents by the FM, given the informational asymmetry about cost. Since the domestic country realizes that the monopolist has the incentive to report $\hat{\theta}>\theta$, where θ denotes true cost parameter, it must construct a commercial policy which discourages overstating costs. To successfully implement this scheme, the DG will have to "penalize" high cost reports and "reward" low cost reports. This scheme is equivalent to assuming that the domestic country can punish the FM with a higher tariff if the monopolist overstates θ. This trade bill can be proposed if the DG realizes that a considerable amount of foreign rents are due to the informational asymmetries about the FM's cost parameters.[6] We know from the Revelation Principle that the DG can safely restrict its attention to "incentive compatible" policies, which induce the FM to truthfully reveal information about its cost parameters.[7] The lack of information faced by the government is now remedied by ensuring the FM will voluntarily report its true cost, but this behavior comes at the cost of adding an incentive compatibility constraint on the available policies. The optimal scheme will induce the FM to self-select its true costs. An individual rationality constraint has also to be introduced to ensure that the FM is willing to participate. The incentive compatible tariff scheme offered in this paper is moderate, unlike one-sided trade policies which do not consider a trade partner's side. The DG now imposes a truth-telling constraint on the set of feasible arrangements between two parties while it also induces the FM to participate in its market by ensuring an opportunity profit. Technically, our study builds upon recent principal-agent models investigating the regulation of domestic monopolist under incomplete cost information (See, for example, Baron and Myerson(1982), Laffont and Tirole(1986), and Lewis and Sappington(1988)).

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[6] On factual ground, the amendment, which has become known as the Gephardt Bill, proposed punishing Japan with higher U.S. tariffs if the bilateral trade deficit is above some predetermined level. The rational behind this bill is that the Japan-U.S. trade deficit is due to hidden protection by the Japanese.

[7] The Revelation Principle is developed in Myerson(1979), Dasgupta, Hammond, and Maskin(1979) and Harris and Townsend(1981). It states for any policy such that the FM with parameter θ finds it optimal to report $\hat{\theta}\neq\theta$ there exists another regulatory policy

In subsection 2.3.1 we derive the optimum tariff under the specific regime. Subsection 2.3.2 develops the corresponding case for the ad valorem regime.

2.3.1 The Case of Specific Tariff Regime

In modelling the tariff decision of the DG we assume throughout that the DG can precommit itself to using a type of tariff instrument, even though it cannot precommit itself to particular levels of tariff instruments. Suppose now that the specific tariff of size t is imposed by the DG. The situation is described in Figure 2.1. Note that with the specification of the general cost function, all the output produced by the FM is assumed to be exported to the domestic country. This simplifying assumption has the effect of

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that is at least as good and induces the FM to report $\hat{\theta}=\theta$ (For a detailed explanation, see Chapter 1).

making the analysis as simple as possible by eliminating the possibility of the FM's discrimination among markets.

The monopolist is assumed to be risk neutral, and its expected profit in the domestic market, when the monopolist announces its cost parameter as $\hat{\theta}$ while its true costs are θ, will be

$$\pi(\hat{\theta} \vdots \theta) = p(\hat{\theta})q(\hat{\theta}) - c(q(\hat{\theta}),\theta) - t(\hat{\theta})q(\hat{\theta}) \tag{2.5}$$

Before proceeding to informational constraints, we examine the effect of changes in t on output. Given $\hat{\theta}=\theta$ and t, maximization of π with respect to q yield the following first-order condition:

$$\pi_q = p + p'q - c_q - t = 0 \tag{2.6}$$

where $p'$is the derivative of inverse demand function $p(q)$. The second-order condition is

$$\pi_{qq} = 2p' + p''q - c_{qq} < 0 \tag{2.7}$$

Eq.(2.6) implicitly defines q as a function of t, provided the conditions of the implicit function theorem hold.[8] Now, for the comparative static effect q_t we totally differentiate Eq.(2.6).

$$\mathrm{d}\pi_q = \pi_{qq}\mathrm{d}q + \pi_{qt}\mathrm{d}t = 0$$

yielding:

$$q_t = \mathrm{d}q/\mathrm{d}t = 1/\pi_{qq} < 0 \tag{2.8}$$

since π_{qq} is negative from (2.7). Eq.(2.8) shows that, naturally enough, increases in the tariff would lower output.

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[8] For Eq.(2.6) to define q as a function t, the solution to (2.6) must exist and be unique for all relevant values of t.

We turn now to the informational constraints. The class of incentive-compatibility policies is defined in terms of the profit of the FM. We first want to guarantee that the FM can never make a greater profit by misreporting than it could by truthfully reporting its cost parameter. Letting $\pi(\theta) \equiv \pi(\theta;\theta)$, this truthtelling(or incentive compatibility) constraint can be expressed as:

$$\pi(\theta) \geq \pi(\hat{\theta} : \theta), \quad \forall\ \hat{\theta}, \theta \in [\theta_0, \theta_1] \tag{2.9}$$

Furthermore, it is realistic to assume that the DG cannot force the FM to sell in its market unless the monopolist can expect at least an opportunity profit. This participation(or individual rationality) constraint is written as:

$$\pi(\theta) \geq 0, \quad \forall\ \theta \in [\theta_0, \theta_1] \tag{2.10}$$

The DG's information about θ is represented by a density function $f(\theta)$ that is positive on the interval $[\theta_0, \theta_1]$ and zero elsewhere. The DG now wishes to choose a tariff that maximizes a weighted sum of expected consumer surplus (CS) plus tariff revenues. For simplicity, the weights on CS and tariff revenues are assumed to be equal and normalized to 1. Then the expected social welfare of the domestic country W is given by

$$W = \int_{\theta_0}^{\theta_1} \{u(q(\theta,t) - p(q(\theta,t))q(\theta,t) + t(\theta)q(\theta,t)\} dF(\theta) \tag{2.11}$$

Using (2.5) (with $\hat{\theta} = \theta$), (2.11) can be simplified and represented as

$$W = \int_{\theta_0}^{\theta_1} \{u(q(\theta,t)) - c(q,\theta) - \pi(\theta)\} f(\theta) d\theta \tag{2.11a}$$

To sum up, the DG's problem (GP) can be stated formally as follows:

$$\underset{t}{Maximize} \quad W \tag{2.12}$$

subject to

$$a) \quad \pi(\theta) \geq 0, \qquad \forall\ \theta \in [\theta_0, \theta_1]$$

$$b) \quad \pi(\theta) \geq \pi(\hat{\theta} : \theta), \qquad \forall\ \theta, \hat{\theta} \in [\theta_0, \theta_1]$$

where $\pi(\hat{\theta} : \theta) = p(q)q(\hat{\theta},t) - c(q,\theta) - t(\hat{\theta})q(\hat{\theta},t)$.

Through its choice of ***t***, the DG maximizes the social welfare function. The constraints (a) and (b) in (2.12) are repeated from (2.10) and (2.9), respectively.

2.3.1.1 The Full-Information Benchmark

The full-information case is interesting because it is a case closer to what the existing literature analyzed. Assuming that the domestic country had complete information about the FM's cost parameters, the constraint (b) is not needed and thus the solution to (2.12) is straightforward. Forming and solving a Lagrangian with $\lambda \geq 0$ as the multiplier for the constraint (a) in (2.12) we obtain the optimum tariff under complete information (See Appendix A):

$$\bar{t} = \lambda(c_q - AC) + (\lambda - 1)\frac{(1 - p_t)q}{q_t} \tag{2.13}$$

where $p_t = p'q_t$ and AC= average cost($\equiv c(\cdot)/q$). It depends on the nature of costs and demands functions. The solution is distinguished by whether the FM's profit constraint is binding or not binding. If the constraint is binding, λ, which can be interpreted as the shadow price of the constraint, is positive: $\lambda > 0$. As long as marginal cost curve is upward sloping by the previous assumptions, the first term in (2.13) is always positive. Assuming the constant marginal costs, however, the first term is canceled out. Eq.(2.13) can be also written as:

$$\bar{t} = \lambda(c_q - AC) - (\lambda - 1)\frac{p_t^f q}{q_t} \tag{2.13a}$$

since $p_t^f = p_t - 1$. (2.13) or (2.13a) reflects the domestic country's incentive to use a tariff to extract rents from a FM. Note that as proved in Appendix A, $\lambda > 1$ in both equations. The possibility of $0 < \lambda < 1$ will not happen as long as both $p > c_q$ which is the necessary condition for positive profits and $q_t < 0$ by the comparative static effect (See (2.8)) hold. If the monopolist's profit constraint is not binding so that $\lambda = 0$, then (2.13) is given by:

$$\bar{t}_{BS} = \frac{(p_t - 1)q}{q_t} \tag{2.13b}$$

Eq.(2.13b) is exactly Brander and Spencer's result (1984a,b)[See (6) and (6') in their paper(1984b)]. $\bar{t}_{BS}$ denotes the optimal tariff derived by Brander and Spencer. Note that we have included the FM's profit in the objective function in the first line of GP (See (2.11a)), so a nonbinding the profit constraint means that the DG is restored to at least its initial welfare level. More simply speaking, the intuition for $\lambda = 0$ is that the DG does not make its policy contingent on the FM's profits. However, a country's trade policies may also be contingent on the foreign firm's profits, say, for a peculiarity of imported good or domestic political considerations. In fact, it may be more reasonable to assume that the FM must earn at least nonnegative profit in equilibrium. Because in this paper we propose a moderate tariff policy which considers the tradepartner's side, this assumption is more appropriate for our purpose. In Brander and Spencer's case, the conditions for the optimal policies are not ambiguous. If an increase in the tariff causes price to rise by less than the tariff increases so that p_t<1, a tariff is the optimal instrument, since q_t<0. Most reasonable demand structures fall into this case. However, it is also possible that if demand is very convex, p_t>1. This possibility implies that specific subsidy may be optimal.[9] In comparison, the sign of $\bar{t}$ in the case of λ>0 is more complicated, because the relevant variables are both λ and p_t. Along with λ>1, an ambiguity in sign of $\bar{t}$ happens in the case of p_t<1, because, although the first term in (2.13) is positive, the second term is negative. When p_t>1, the optimal policy innstrument is clearly tariff. This result is sharply contrast to Brander and Spencer's. When p_t=1, in both cases about the range of λ values, the DG must impose the tariff according to the difference between the monopolist's marginal and average costs. Finally, note from the maximization problem that the pricing schedule equals average cost plus a tariff so that π=0. Then we can infer that any positive profit is due to the informational advantage of the monopolist, and thus the profits can be interpreted as informational rents.

2.3.1.2 The Optimum Tariff under Incomplete Information

The full-information case studied in the above is just an abstraction. When announcing its cost parameter and choosing its level of output, the FM behaves strategically. As mentioned before, the FM has incentive to falsely announce its cost parameter to obtain a higher price and thereby a higher profit. Thus we argue that the optimum tariff under complete information tends to be less than its desired level in terms of social welfare. Of central concern here is how the DG can design the tariff to extract the additional monopoly rents that occur because of the informational asymmetries.

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[9] This possibility is absent in the normal optimal tariff problem where it is assumed that the world market is competitive. It is worth noting however that Tower(1983) derives this same result (that an import subsidy may be optimal depending on the curvature of the demand curve) in a competitive markets model in which the foreign government is a Stackelberg follower with its tariff (See, in particular, his propositions 7 and 9).

Suppose now that the DG is "sophisticated", in the sense that it, by designing a truthful revelation mechanism, can effectively make the trade policy contingent on the FM's true cost parameters. The rationale behind this incentive-compatibility policy is that a considerable amount of foreign monopoly rents is due to informational asymmetries, not based on its actual cost parameter. The GP is then to maximize $\boldsymbol{W}$ in (2.12) subject to the feasibility constraints in (a) and (b).

From the incentive literature (See, for example, Guesnerie and Laffont(1984)), we know the conditions for incentive compatibility. Viewing $\pi(\theta)$ as a state variable and assuming that the mechanism is differentiable, a characterization of the mechanism which satisfies the IC constraint is as follows:

Lemma2.1: For any incentive compatible mechanism, given the assumptions about the cost function,

(a) $\pi'(\theta) = - c_\theta(q(\theta,t),\theta)$;

(b) $q(\theta,t)$ is nonincreasing for all θ.

Condition (a) and monotonicity of $q(\theta)$ result, respectively, from first-order and second-order incentive compatibility conditions. The proof is in Appendix B.

To provide some explanation for (a), let us differentiate $\pi(\theta)$ with respect to θ.

$$\pi'(\theta) = \left.\frac{d\pi(\hat{\theta} \mathbin{\vdots} \theta)}{d\theta}\right|_{\hat{\theta}=\theta}$$

$$= \left.\frac{\partial\pi(\hat{\theta} \mathbin{\vdots} \theta)}{\partial\hat{\theta}}\right|_{\hat{\theta}=\theta}\frac{d\hat{\theta}}{d\theta} + \left.\frac{\partial\pi(\hat{\theta} \mathbin{\vdots} \theta)}{\partial\theta}\right|_{\hat{\theta}=\theta}\frac{d\theta}{d\theta} \tag{2.14}$$

This expression means that the total change in profit $\pi'(\theta)$ consists of the effect of changing the report $\hat{\theta}$, and the effect of changing the true cost θ. For an IC policy, $\hat{\theta}(\theta) = \theta$ maximizes $\pi(\hat{\theta} \mathbin{\vdots} \theta)$, so $(\partial\pi(\hat{\theta} \mathbin{\vdots} \theta)/\partial\hat{\theta})|_{\hat{\theta}=\theta} = 0$, meaning that the FM finds it in its best interest to report the true value of θ. The derivative of the state variable thus is :

$$\pi'(\theta) = \left.\frac{\partial\pi(\hat{\theta} \mathbin{\vdots} \theta)}{\partial\theta}\right|_{\hat{\theta}=\theta}$$

$$= -c_\theta(q,\theta) \tag{2.15}$$

This represents the equation of motion for the state variable. Since a derivative is a local property of a function, (2.15) is a local condition that indicates that for any IC mechanism the profit of the monopolist viewed across the possible types is a decreasing function of θ. When the FM has a high cost parameter, its profit is thus less than the profit when low cost for any IC mechanism. From the monotonicity property, the expected output is higher for low-cost case than for high-cost case.

Integrating the first-order linear differential equation (2.15) from θ to θ_1 yields

$$\pi(\theta) = \pi(\theta_1) + \int_{\theta}^{\theta_1} c_\theta(q(\tilde{\theta},t),\tilde{\theta})d\tilde{\theta} \tag{2.16}$$

This expression defines the rent that must be paid to low-cost FM to induce truthful revelation. Since π is decreasing in θ from (2.15) and the DG would like to extract as much profits as possible from the monopolist, the highest-cost monopolist ($\theta=\theta_1$) will earn no rents. Thus, the IR constraint has two terminal points.

Lemma2.2: $\pi(\theta_1)=0$, and $\pi(\theta_0)$ is free.

Now it remains to determine the property that the optimum tariff requires for any incentive compatible mechanism. It is straightforward from the proceeding observations.

Lemma2.3: If $q_\theta \leq 0$, along with $q_t<0$, then t_θ must be positive $\forall\theta$ in any incentive compatible tariff policy.

This is the property any incentive compatible tariff function must have. In Figure 2.2, the SE-quadrant represents the relation between t and θ.

Under incomplete information the DG now maximizes expected social welfare subject to the first-and second-order incentive constraints, and to the individual rationality constraint of the FM. Formally, we have:

$$\underset{t}{Maximize} \quad W=\int_{\theta_0}^{\theta_1}\{u(q(\theta,t))-c(q(\theta,t),\theta)-\pi(\theta)\}f(\theta)d\theta \tag{2.12a}$$

s.t.

$$a)\,\pi(\theta_1)\geq 0$$

$$b)\,\pi'(\theta)=-c_\theta(q(\theta,t),\theta)$$

$$c)\,q_\theta(\cdot)\leq 0 \Rightarrow t_\theta > 0$$

Note again that the profit of $\pi(\theta)$ here is a state variable, which for an incentive compatible policy has the form given in (2.16). The constraint that $t(\cdot)$ is increasing in

θ is difficult to incorporate into a mathematical program without assuming that $t(\cdot)$ is differentiable. The approach taken here is to ignore this constraint and then to check if the solution obtained has the required property. We later specify the sufficient condition for this constraint to hold. By applying the maximum principle to the GP or using integration by parts (See Appendix C), we obtain the (specific) optimum tariff.

Letting $\mu(\theta)$ denote the costate variable associated with $\pi(\theta)$, the Hamiltonian ***H*** for the control problem is:

$$H = \{u(q(\theta,t)) - c(q(\theta,t),\theta) - \pi(\theta)\}f(\theta) - \mu(\theta)c_\theta(q(\theta,t),\theta) \tag{2.17}$$

The necessary conditions for an optimum are:[10]

$$\partial H/\partial t = (u'q_t - c_q q_t)f(\theta) - \mu(\theta)c_{\theta q}(\cdot)q_t = 0 \tag{2.18}$$

$$\partial H/\partial \pi = -\frac{d\mu}{d\theta} \rightarrow -f(\theta) = -\frac{d\mu}{d\theta} \tag{2.19}$$

$$\partial H/\partial \mu = \pi'(\theta) \rightarrow -c_\theta(q(\theta,t),\theta) = \pi'(\theta) \tag{2.20}$$

$$\mu(\theta_0)\pi(\theta_0) = \mu(\theta_1)\pi(\theta_1) = 0 \tag{2.21}$$

Note that (2.21) is a transversality condition (TVC).

Lemma2.4: The costate variable $\mu(\theta)$ is non-negative for all θ with $\mu(\theta_0)=0$, and $\mu(\theta_1)\pi(\theta_1)=0$.

Proof: The strict proof follows closely the proof of Baron and Besanko(1984) and hence will only be sketched here. The proof is implied by Lemma 2.2. The result that $\mu(\theta_1)\pi(\theta_1)=0$ is immediate from TVC. Also, from the latter in Lemma 2.2 we get $\mu(\theta_0)=0$.

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[10] The conditions are also sufficient because $W(q,t)$ are strictly concave in q.

To characterize the optimal tariff policy, integrating (2.19) and using $\mu(\theta_0)=0$ yields

$$\mu(\theta) = F(\theta) \tag{2.19a}$$

where $F(\theta)$ is the distribution function corresponding to $f(\theta)$.

On the other hand, we know from the first-order condition of Eq.(2.5) with respect to t, in equilibrium, that

$$pq_t - c_q q_t = (1-p_t)q + tq_t \tag{2.22}$$

where $p_t = p'q_t$. Substituting for μ and (2.22) in Eq.(2.18) and rearranging we obtain the optimum tariff, denoted by an t_c^*, under incomplete information:

$$t_c^*(\theta) \;=\; \frac{(p_t-1)q}{q_t} + \frac{F(\theta)}{f(\theta)}\, c_{\theta q}(q,\theta) \tag{2.23}$$

And then the profit of the FM is

$$\pi^*(\theta) = \int_{\theta}^{\theta_1} c_\theta(q(\tilde{\theta},t_c^*),\tilde{\theta})d\tilde{\theta} \tag{2.24}$$

Eq.(2.24) is derived from (2.16), by noting Lemma 2.2.

Eq.(2.23) defines the rent-extracting tariff under incomplete information. The DG must now set tariffs greater than optimum tariff under full information because of the informational asymmetry. The assumptions made about cost and demand functions ensure that the welfare function as stated in (2.11) is strictly concave. This in turn implies that $t_c^*(\theta)$ is unique. From (2.23) we do know that the optimum tariff should now reflect the informational asymmetry and thus it will be higher than its full information counterpart with most reasonable demand curves. This can be seen from comparing (2.13b) with

(2.23); in the latter there is an additional expression, $c_{\theta q}(q,\theta)[F(\theta)/f(\theta)]$, which captures the rents retained by the FM for all cost realizations that are higher than θ_0.

We are now ready to compare the tariff policy under full and imperfect information. For analytical comparison, we here restrict our attention to (2.13b). Because Eq.(2.13b) is the optimal tariff when no informational constraints are considered. We summarize this comparison in the following proposition.

Proposition 2.1: (i) $t_c^*(\theta) > \bar{t}_{BS}(\theta)$, *for all* $\theta > \theta_0$ *and* $t_c^*(\theta_0) = \bar{t}_{BS}(\theta_0)$;

(ii) $\pi^*(\theta) \geq \pi^*(\theta_1) = \bar{\pi}(\theta)$ *for all* θ, *and*

(iii) $W^*(\theta,t) \leq \bar{W}(\theta,t)$, *for each* θ.

where superscripts * and – indicate the optimal values under incomplete information and complete information, respectively. From (i) we know that Brander and Spencer's result, from our model's perspective, holds only at the most efficient cost level θ_0. This also reports that the DG imposes the punitive tariff for the higher cost realizations. Such a scheme helps mitigate the FM's incentive to exaggerate cost. Formally, differentiating (2.5) with respect to report cost $\hat{\theta}$ and evaluating it at $\hat{\theta}=\theta$, we obtain

$$\pi_1(\hat{\theta} : \theta)\Big|_{\hat{\theta}=\theta} = -t_\theta(\theta)q(\theta,t) < 0 \quad \text{(By Lemma 2.3)}$$

Under the incentive-compatibility tariff scheme, therefore, the FM would have an incentive to announce a lower value of θ than actually occurred. (ii) follows from the fact that $\pi(\theta)$ is decreasing in θ (See Lemma 2.1). This states that the FM will earn rents from its private technological information whenever $\theta < \theta_1$. These rents are what induce the FM admit to having other than the highest possible cost realization. To show (iii) note that the objective function (2.11a) is the same under both full and imperfect information; however, the imperfect information maximization problem involves an additional constraint (i.e., the incentive compatibility constraint). Therefore, by the Le Chatelier principle (iii) holds for each θ. Also with (ii), recalling that W is decreasing function in π (iii) is clear.

Let us now look at the implications of optimal policy under incomplete information. As indicated in (i) above, $t_c^*(\theta)$ is reduced to (2.13b) at $\theta=\theta_0$, since $F(\theta_0)=0$. Then the question of whether $t_c^*(\theta)$ is positive depends again on the demand structure, as mentioned earlier. Similarly, at $\theta=\theta_1$

$$t_c^*(\theta)=(p_t-1)q/q_t + c_{\theta q}(\cdot)/f(\theta_1).$$

With this work done we have an immediate policy implications as follows and Figure 2.3 illustrates the results:

Proposition 2.2: *If the tariff policy is continuous in* θ*, and the domestic demand is not very convex (*$p_t<1$*), the optimal policy instrument is a tariff for all* θ*. The tariff is largest for* θ_1 *and smallest for* θ_0*.*

Proposition 2.3: *With too convex demand structure(*$p_t>1$*) all policies in the model are possible: tariff, subsidy and free trade policies.*

The possibility for Proposition 2.3 comes from the fact that with $p_t>1$ the first term and the second term in (2.23) have opposite signs. Note that the sign of the first term is determined by the demand condition, p_t for all θ, while the second term due to asymmetric information is positive and its extent depends on values of θ. In the model, in particular, free trade policy arises from two possibilities. The first case is one when $\theta=\theta_0$ and $p_f=1$. This situation can occur when the domestic market is competitive and thus the FM is just one of many suppliers. The long run supply curve is now horizontal at θ_0, although individual firms may have U-shaped average cost curves. Then a tariff causes an equal increase in the domestic price. More interestingly, with $p_f>1$ free trade policy may exist: If the tariff policy is continuous in θ and there exists $\theta_0<\tilde{\theta}<\theta_1$ such that the extent of subsidy due to the demand condition (the negative first term in (2.23)) is the same as the extent of the tariff due to the informational asymmetry, then $t_c^*(\theta)=0$ and the optimum policy is free trade.

From Lemma 2.3 we know that $t(\theta)$ must be increasing in θ to satisfy the second-order condition for incentive compatibility. We finally characterize the sufficient condition for this to hold. The conditions are connected to the question of how the optimum tariff, $t_c^*(\theta)$, varies with θ. The effect of changes in θ on the tariff consists of the effects on $\bar{t}_{BS}$ (the first term in (2.23) which is the same as (2.13b)) and an additional component dealing with the informational asymmetry (the second term). The most convenient method of analysis is to consider the two effects separately. The assumptions about the cost function along with the assumption that $F(\theta)/f(\theta)$ is nondecreasing creates the positive sign in the second term in (2.23). The annoying problem is the effect on $\bar{t}_{BS}$ .As seen before, given θ, the DG maximizes (2.11) with respect to t. The first order condition is

$$W_t = q - p_f q + t q_t = 0 \tag{2.25}$$

Provided the second-order condition $W_{tt}<0$ is satisfied, expression (2.13b) characterizes the solution for t given θ. If this solution is unique for all θ, then (2.13b) implicitly defines $t=t(\theta)$. Then the effect of θ on the tariff can be calculated by totally differentiating (2.25) with respect to t and θ to obtain:

$$t_\theta = \mathrm{d}t/\mathrm{d}\theta = -W_{t\theta}/W_{tt} \tag{2.26}$$

W_{tt} is negative by the second-order condition for maximization of W. Therefore t_θ has the same sign as $W_{t\theta}$. By Lemma 2.3, however, $W_{t\theta}>0$, leading to an optimal tariff rate that would be increasing in the cost parameter. Differentiation of (2.25) with respect to θ and some algebraic manipulation, as shown in the Appendix D, yields:

$$W_{t\theta} = q_t q_\theta (p^{\prime} - c_{qq}) + q_{t\theta}(p - c_q) \tag{2.27}$$

where $q_{t\theta} = -q_t^2[(3p^{\prime\prime} + p^{\prime\prime\prime}q)q_\theta - dc_{qq}/d\theta]$. The sign of $q_{t\theta}$ is ambiguous. The sign of $W_{t\theta}$ is, therefore, ambiguous. However, with the preceding observations on q with respect to t and θ and assumptions about cost function the sufficient conditions for $W_{t\theta}>0$ which leads to the incentive compatible tariff are:

(i) $q_{t\theta}>0$, and

(ii) $q_t q_\theta (p^{\prime} - c_{qq}) < q_{t\theta}(p - c_q)$ (2.28)

With $q_{t\theta}>0$ an increase in cost parameter would lessen the fall in output from a small increase in tariff rate. $q_{t\theta}$ is sufficiently positive if c_{qq} is small increasing in θ. The second condition in (2.28) is not easy to check when dealing with general functions and also is not easy to interpret in an intuitive way. From the RHS in (ii), we know that $p>c_q$, because of the necessary condition that the monopoly profits can be positive in the domestic market. Thus, with $q_{t\theta}>0$ RHS will be positive. On the other hand, LHS is negative, given assumptions about the demand and cost functions along with observations on q with respect to θ and t. (2.28) may be a strong condition; even if it does not hold in a particular case we may still have existence of the tariff function. As usual, it may be easier to check directly the sign of $t(\theta)$ with respect to θ from (2.23). If positivity holds we can be sure that the tariff function exists and is well behaved.

2.3.2 The Case of Ad Valorem Tariff Regime

Our discussion has so far been restricted to specific tariffs and subsidies, where the tax or subsidy is a fixed sum per physical unit. However, there is an alternative tariff/subsidy regime: an ad valorem tariff and subsidy. In real life it is more common for taxes and subsidies to be specified in ad valorem terms, that is, as a percentage of the selling price. In a perfectly competitive industry this makes no difference: as long as a specific and an ad valorem tax drive the same wedge between producer and consumer prices, they have the same effect. In the current context, however, there is a difference.[11]

Consider now an ad valorem tariff or subsidy. If p^f denotes the foreign price of a good subject to an ad valorem rate τ, then the domestic price p is

$$p = p^f(1 + \tau) \tag{2.29}$$

The domestic price consists of the payment to the foreigner, p^f, plus the import tax (or the tariff revenue per unit of imports), $p^f\,\tau$. Denoting the import tax by ξ total tariff revenue can be written ξq. The profit function of the FM is then

$$\pi(\hat{\theta} : \theta) = p(\hat{\theta})q(\hat{\theta}) - c(q(\hat{\theta}),\theta) - \tau(\hat{\theta})p^f q(\hat{\theta}) \tag{2.5a}$$

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[11] An ad valorem tariff affects the first-order condition of the FM in a structurally different way than does a specific tariff and therefore, given demand and cost conditions, gives rise to different price effects.

Using $\tau p^f = \tau p/(1+\tau)$, (2.5a) can also be written

$$\pi(\hat{\theta} : \theta) = \frac{p(\hat{\theta})q(\hat{\theta})}{1+\tau(\hat{\theta})} - c(q(\hat{\theta}),\theta) \tag{2.5b}$$

Note that as in the specific tariff case, it is easily shown that q_τ is negative using the second-order condition from (2.5a). The objective function of the domestic country is now

$$W = \int_{\theta_0}^{\theta_1} \{u(q(\theta,\tau)) - p(q(\theta,\tau))q(\theta,\tau) + \tau(\theta)p^f q(\theta,\tau)\} dF(\theta) \tag{2.30}$$

From (2.5a), (2.30) can be rewritten as

$$W = \int_{\theta_0}^{\theta_1} \{u(q(\theta,\tau)) - c(q,\theta) - \pi(\theta)\} f(\theta) d\theta \tag{2.30a}$$

2.3.2.1 The Optimal Ad Valorem Tariff under Complete Information

First, let us obtain the optimal ad valorem tariff under full information. Formally, the GP is to choose τ to maximize the objective function, W, subject to the constraint that the FM earns at least its reservation profits, $\pi(\cdot) \geq 0$.

The optimum ad valorem tariff is obtained in the same manner as for the specific case:

$$\bar{\tau} = \lambda \frac{(c_q(\cdot) - AC)q_\tau}{\Delta NR - \lambda p_\tau^f q} + (\lambda - 1) \frac{(p^f - p_\tau)q}{\Delta NR - \lambda p_\tau^f q} \tag{2.31}$$

where λ is a Lagrange multiplier and ΔNR indicates the change of the FM's net revenue to an ad valorem tariff; i.e., $\Delta NR = p_\tau^f q + p^f q_\tau$. Also, $p_\tau = p' q_\tau$ and $p_\tau^f = p^{f\prime} q_\tau$. To obtain the intuitive implications let us rewrite Eq.(2.31) in terms of ξ:

$$\bar{\xi} = \lambda(c_q(\cdot) - AC) + (\lambda - 1)\frac{(\xi_\tau - p_\tau)q}{q_\tau} \tag{2.32}$$

If the IR constraint is not binding so that $\lambda=0$, (2.31) and (2.32), respectively, become

$$\bar{\tau} = \frac{(p_\tau - p^f)q}{\Delta NR} \tag{2.31a}$$

and

$$\bar{\xi}_{BS} = \frac{(p_\tau - \xi_\tau)q}{q_\tau} \tag{2.32a}$$

Also, substituting $p_\tau^f = p_\tau - \xi_\tau$ in (2.32) and (2.32a) we obtain

$$\bar{\xi} = \lambda(c_q(\cdot) - AC) - (\lambda - 1)\frac{p_\tau^f q}{q_\tau} \tag{2.32b}$$

and $$\bar{\xi}_{BS} = \frac{p_\tau^f q}{q_\tau} \tag{2.32c}$$

Eqs.(2.32a) and (2.32c) are the same as Brander and Spencer's (1984b). It is more convenient to interpret (2.32) than (2.31). Eqs.(2.32b) and (2.32c) take the same forms as ones in the specific regime (see (2.13a) and (2.13b)). However, an ad valorem tariff affects a FM's behavior differently than does a specific tariff and thus the conditions for the comparative effect of the tariff on supply price differ from ones in the specific case. In the case of Brander and Spencer (1984a,b), the optimum tariff condition with $q_\tau<0$ is, from (2.32c), $p_\tau^f<0$. From (2.32b) the sign of $\bar{\xi}$ is, however, determined by both λ and p_τ^f. We find again that the possibility for $0<\lambda<1$ is excluded because of the same reason as in the specific case. In the case of a binding IR constraint, therefore, the optimum tariff condition is sharply contrasted to the optimal condition in the Brander and Spencer's paper: whenever $p_\tau^f>0$, clearly $\bar{\xi}>0$ which implies an optimum tariff. When $p_\tau^f<0$ the sign of $\bar{\xi}$, rather, is ambiguous; the optimum tariff occurs only when the negative second term is dominated by the positive first term. The sign of p^f_τ in turn depends on the elasticity of demand, η and whether η rises or falls along the demand curve. To determine the sign of p^f_τ, consider the profit-maximizing problem of the FM; at $\hat{\theta}=\theta$ from (2.5b) the first-order condition is

$$\frac{p+p'q}{1+\tau}-c_q=0$$

By an appropriate manipulation we obtain:

$$p^f\equiv\frac{p}{1+\tau}=\frac{\eta c_q}{\eta-1} \tag{2.33}$$

where η=-$p/qp'(q)$. Taking the derivative of (2.33) yields:

$$p^f_\tau=\frac{\eta c_{qq}q_\tau}{\eta-1}-\frac{\eta_q c_q q_\tau}{(\eta-1)^2} \tag{2.34}$$

where η_q is the change in the elasticity of demand along the demand curve(≡dη/dq). Thus, if marginal cost is increasing rather than constant, the sign of p^f_τ depends on the measure of elasticity of demand as well as η_q. If the marginal cost is constant, as in Brander and Spencer (1984a,b), (2.34) reduces to (2.34a):

$$p^f_\tau=-\frac{\eta_q c_q q_\tau}{(\eta-1)^2} \tag{2.34a}$$

Thus the sign of p^f_τ depends on η_q. This in conjunction with (2.32b) and (2.32c), respectively yields the following result:

If	then	Optimal Policies (from (2.32b))	Optimal Policies (from (2.32c))
$\eta_q>0$	$p_\tau^f>0$	tariff	subsidy
$\eta_q=0$	$p_\tau^f=0$	nonintervention	nonintervention
$\eta_q<0$	$p_\tau^f<0$	subsidy	tariff

Policy instruments obtained at (2.32b), the solution of the problem that considers the IR constraints are reversed to those obtained from (2.32c) which is a solution when no informational constraints are considered.

2.3.2.2 Ad Valorem Tariff under Imperfect Information

We now proceed to examine the more realistic asymmetric information case, i.e., when the realization of the cost parameter is known to the FM but not observable by the DG. With the profit function (2.5a) the informational constraints (2.9),(2.10) and conditions for IC are the same as in the specific case, except putting τ instead of t. If we now apply the maximum principle to the GP with the welfare function (2.30a) subject to feasibility constraints, we obtain the optimal ad valorem tariff under incomplete information (details are in Appendix E):

$$\tau^*(\theta) = \frac{(p_\tau - p^f)q}{\Delta NR} + \frac{F(\theta)}{f(\theta)} c_{\theta q}(q,\theta) q_\tau \qquad (2.35)$$

Also, in terms of ξ

$$\xi^*(\theta) = \frac{p_\tau^f q}{q_\tau} + \frac{F(\theta)}{f(\theta)} c_{\theta q}(q,\theta) \tag{2.36}$$

The results above can be interpreted in the same way as the specific case. Once again, Brander and Spencer's outcomes are, in view of this model, obtained only at the lowest cost level. We find here that the optimum ad valorem tariff under imperfect information is lower than under full information, for all θ except for the lowest realization of costs, θ_0. However, this result should not be surprising. Comparing (2.36) with (2.32a), the tariff revenue per unit of imports associated with an ad valorem tariff τ is more under imperfect information than under full information. This in turn implies that the producer price under imperfect information is high enough to bring more tariff revenue per unit. We can expect this phenomenon, because, as discussed before, the FM has an incentive to overstate its cost parameters to obtain a higher price and thereby higher profits.

The same logic extends to the case of an ad valorem regime, as the following policy implications record.

Proposition 2.4: *If the policy is continuous in θ and $p_\tau^f<0$, given the necessary assumptions and observations, the optimal policy is a tariff for all θ. However, when $p_\tau^f>0$ the sign of $\xi^*(\theta)$ is ambiguous and therefore, tariff and free trade as well as subsidy can be the optimal policy, depending upon the strength in sign of the demand condition and the information component: If the information component (the second term in (2.36)) dominates the negative first term at a particular θ higher than θ_0, then the optimal policy would be tariff.*

The discussion of the possibility for free trade is very analogous to one in the specific case and so is omitted. The sufficient condition for the incentive compatible tariff also follows similar steps as the preceding case. Because an ad valorem tariff affects a FM's behavior differently than does a specific tariff, however, it may be more troublesome to show explicitly the sufficient condition for incentive compatibility. In some cases it is probably easier to follow: just compute $d\xi^{*}(\theta)/d\theta$ from (2.36) and check whether it is positive.

Finally, we can ask whether a specific or an ad valorem regime is welfare superior. However, as pointed out by Brander and Spencer, we have found this natural question difficult to answer in general. As for which of these is better, only explicit calculation under special cases can say; that is, the comparison of tariff policy regimes, either a combined specific and ad valorem tariff or pure regime, can be made only under special cases, apart from administrative costs.

2.4 Concluding Remarks

In this paper we have derived the incentive-compatible tariff schedule as a means of capturing foreign-monopoly rents under incomplete information. The model examined here can be viewed as complement of the optimal tariff theory under complete information in that it explores the consequences of incomplete information.

The broader insight we draw from this chapter is that informational asymmetries play a crucial role in designing the optimal tariff policy. A government which fails to recognize that it is limited in its information will find its tariff will not achieve the desired outcome.

Both specific and ad valorem tariffs were examined. Under both regimes some results are observed: (i) the optimal rent-extracting tariffs in the full information case, in view of our model which is subject to informational constraints, hold only at the lowest realization of costs. Furthermore, if we are considering the foreign firm's participation constraint in the model, even under full information case, the critical condition for the optimal tariff policy is sharply contrast to Brander and Spencer's result (1984) in both regimes; (ii) the foreign monopolist's informational advantage enables it to retain higher profits than would have been possible in the absence of such an advantage; (iii) the domestic government's informational disadvantage leads to a lower level of welfare than it would have enjoyed under full information; (iv) Under informational asymmetries the possibilities of a subsidy policy are fewer than ones of a tariff policy in both regimes. This implicitly means that tariffs become more likely to be attractive tools to extract foreign rents than subsidies, when the importing country is constrained by incomplete information. Also, if the policy is continuous in θ, rather surprisingly, there exists a possibility for free trade as a welfare-improving policy, depending upon the demand structure and the informational distortions.

Our analysis has so far been restricted to import tariffs as policy instrument. As suggested in the theory of strategic trade policy, however, we can consider other policy tools such as a quota or voluntary import expansion (VIE).[12] If we set up the model of quota or VIE in our context above, then the domestic country's commercial policy would be defined as $q(\hat{\theta})$. That is, the domestic government views q as a restriction on imports, but the foreign monopolist views q as a restriction on exports. This in turn means that the domestic government sets a market price indirectly by setting an import levels. Under such a setting the optimal solution (i.e., optimal import level) will be Baron and Myerson's (1982) type. Further analysis would be needed to compare policy instruments in terms of the domestic country's welfare.

As a final point, one might ask the following: Is the tariff policy sensitive to the source of uncertainty? For example, a national government may be faced with uncertainty regarding its local demand, rather than the foreign firm's techonology. Clearly we need additional research to arrive at any general conclusions about appropriate tariff policy in the presence of asymmetric information. This discussion will be analyzed in Chapter 3.

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[12] VIE, named by Bhagwati(1987), is another policy instrument which can be employed by the importing country. For the economic effects of VIE, in particular, see Dinopoulos and Kreinin(1990).

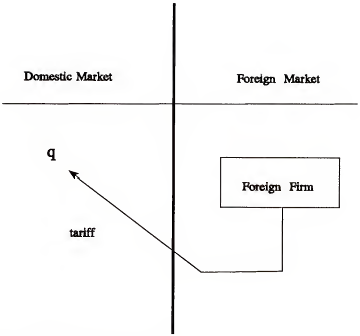


Figure 2.1: The Export Model

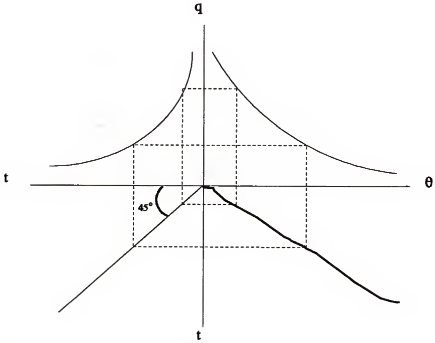
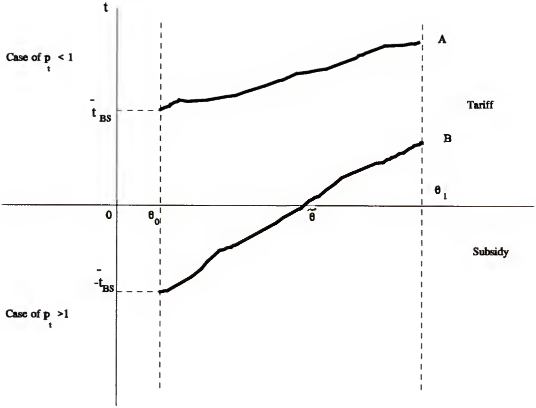


Figure 2.2: Derivation of the Incentive Compatible Tariff Schedule



Note:

A= $\bar{t}_{BS}+\frac{c_{\theta q}}{f(\theta_1)}$ and

B= $-\bar{t}_{BS}+\frac{c_{\theta q}}{f(\theta_1)}$ $s.t.$ $-\bar{t}_{BS}<\frac{c_{\theta q}}{f(\theta_1)}$.

Figure 2.3: Demand Structure and Optimal Policies

CHAPTER 3
RENT-EXTRACTING TARIFFS IN THE PRESENCE OF ASYMMETRIC DEMAND INFORMATION

3.1 Introduction

One important aspect of imperfect competition is that the priced charged for a good exceeds the marginal cost of production. Thus a country importing such a good usually pays a monopoly rent to the exporting firm. One of well-known results from the international trade theory with imperfect competition is that a national government could use tariffs to extract rents from a foreign multinational firm. This case, analyzed first by Katrak (1977), provides an argument for protection which is both interesting and novel. Subsequent papers (e.g., Svedberg (1979), DeMeza (1979), Brander and Spencer (1984a,b)) have extended this line of research.[1] In particular, Brander and Spencer elaborated the rent-shifting argument for protection by deriving the critical conditions for the use of a tariff or subsidy as a means of capturing foreign-monopoly rents.

In this chapter, we generalize an elegant and influential result by Brander and Spencer by considering the central information problem explicitly. From the perspective of the importing country, there are largely two sources of uncertainty: its local demand and the foreign firm's cost. This chapter, in the light of the extensive research to Chapter 2 with asymmetric cost information, analyzes the case in which the source of uncertainty is the demand. We assume throughout the chapter that the domestic demand is uncertain and that a foreign multinational possesses better information about the domestic demand conditions than does the domestic government. To focus on the effect of asymmetric demand information on the domestic government's tariff, we shall also assume that the foreign firm's costs are common knowledge. In sum, the purpose of this chapter is to characterize optimal tariff policy when a national government is imperfectly informed about demand, and to contrast it with the tariff policy that would be undertaken in the presence of complete information. In addition, with the comparison of results in this chapter and Chapter2, we can answer the question of whether the implications of tariff policy are sensitive to the source of uncertainty (costs versus demand).

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[1] For a survey, see Helpman and Krugman(1989), Chapter 4.

We now face the question of why the foreign firm has better information about the domestic-country's demand. We will not discuss here the question sufficiently. Let us just mention that although the foreign firm's domestic demand information may not be inherently private, it is costly for the domestic government to monitor completely and thus the task of investigating and monitoring the market demand is a daunting one for most governments. In particular, less developed countries'(LDCs) governments are likely to be unprepared to monitor their local demands. Even if LDCs were prepared to monitor market demands, the foreign firms may posses better marketing technique or specific information that makes such monitoring highly suspect. We find, from the firm-specific attribute theory on MNEs, that this issue is quite convincing. Unlike neoclassical theory, the initial core of modern theory of the MNEs rests partly on the argument that most firms must have some advantages over other firms before they can operate successfully abroad.[2] That is, recently developed explanations of MNEs have emphasized that to offset many disadvantages foreign firms often face, a successful foreign firm must usually have an asset or skill that is not possessed by other firms including local firms.[3] Basically, the need for firm-specific advantages is a product of the nature of nationalistic governments and the high cost of information. At any case, it is arguable that a successful MNE has gained worldwide dominance and have developed techniques to *learn in advance* local conditions - products, processes, management style, marketing techniques are continually adapted to local markets. In particular, to keep a monopolistic position, if there are no local producers, the MNEs will try to forecast and adapt to the local economic situation. Such a managerial know-how of a MNEs may give it a superior information about the local demand.

The chapter is organized as follows. Section 3.2 presents the model. As a benchmark solution, the optimal tariff under complete information is presented in section 3.3. Incentive compatible mechanisms and the optimal tariff under asymmetric demand information are characterized in section 3.4. The last section 3.5 presents some concluding remarks.

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[2] This important idea is often credited to H. Hymer's 1960 dissertation at MIT, later published as *The International Operations of National Firms:A Study of Direct Foreign Investment*(Cambridge,Mass.:MIT Press, 1976). For work drawing on the idea, see, for example, Caves(1971, 1974).

[3] See Caves(1982) and Buckley and Casson(1985) for a review of research on MNEs. See Dunning(1985) for effects of MNEs on economic structure or changes in economic structure in a selection of countries in the 1970s. Recent research by Benvignati(1987) is particularly relevant to the profitability of MNE.

3.2 Statement of the Model

Consider a foreign firm that is the single foreign supplier of a commodity to the domestic market. We assume that there is no domestic supply, so that domestic demand for imports can simply be expressed as a downward-sloping demand curve whose elasticity determines the foreign firm's monopoly power. In such a situation, the domestic government (hereafter DG) may gain by using a tariff as a means of extracting these foreign rents. The foreign monopolist (FM) and the DG are assumed to be risk neutral.[4]

For simplicity, we adopt a long run perspective in defining the FM's cost function and thus assume a constant returns to scale. Formally, $C(q)=cq$, where c is a constant marginal cost. We let $U(q,\theta)$ denote the gross utility function of the representative domestic consumer. The parameter θ is a random variable of domestic consumer preferences whose value is assumed to be known to the FM but not to the DG. For analytical convenience, we assume that this utility function takes a form of quasi-linear function so that $p=U_q(q,\theta)$, where subscript denotes partial derivatives(here and throughout) and p is a price per unit of output. Consumer surplus is then $U(q,\theta) - pq$. Assume that $P_q(q,\theta)<0$ and $P_\theta(q,\theta)>0$ for all relevant q and θ, where $P(\cdot)$denotes the domestic country's inverse demand function. Note that the source of uncertainty we consider here pertains to the positions, but not the shape, of the domestic demand function.[5] We let $f(\theta)$ and $F(\theta)$ be, respectively, the density function and the cumulative distribution function for θ, with $f(\theta)>0$, $\forall\theta\varepsilon[\theta^l,\theta^h]$. Under asymmetric information, the DG does not know the realization of θ. Faced with this information gap, the DG is assumed to behave as a Bayesian statistician. That is, based upon his prior beliefs (as captured in $f(\theta)$), the DG designs the tariff policy to maximize expected social welfare. Then, the FM chooses one of the tariff schedules by choosing θ. Here the FM is required to make a demand report, $\hat{\theta}$, to the DG. Once the demand report has been made the FM is required to provide exactly $q(t(\hat{\theta}),\theta)$ and will receive a price of $p(q(t(\hat{\theta}),\theta),\theta)$. Finally, exports occur to serve all demand at the established tariff. This is the timing of the game under incomplete information. Note that the FM's participation in this environment is voluntary, since it can always choose not to export and earn its reservation profit level (normalized at zero) rather than choose one of the tariff options stipulated by the DG. In what follows we impose the following regularity condition: $d/d\theta\{(1- F(\theta))/f(\theta)\}\leq 0$ for all θ. This assumption is the classical non-increasing hazard rate property.[6]

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[4] This assumption enables us to separate the potentially confounding influence of varying attitudes towards risk from the focus of the paper.

[5] Although more generality might be desirable, as Lewis and Sappington(1988b) point out, it comes at the expense of considerable mathematical complexity. In particular, the

3.2.1 The Foreign Monopolist's Problem

Let $\pi(\hat{\theta}:\theta)$ denote the profit of the FM if it announces $\hat{\theta}$ when θ is the actual value. $\pi(\hat{\theta}:\theta)$ is defined by

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solution generated by considering only the local representation of the incentive-compatibility constraints will not necessarily satisfy the global-incentive-compatibility constraints (See Lewis and Sappington's Lemma 2).

[6] This regularity condition is typically assumed to avoid bunching or pooling without significant loss for the economics of the problem in the incentive compatible policy. See Guesnerie and Laffont(1984).

$$\pi(\hat{\theta}:\theta) = p(q(t(\hat{\theta}),\theta),\theta)q(t(\hat{\theta}),\theta) - cq(t(\hat{\theta}),\theta) - t(\hat{\theta})q(t(\hat{\theta}),\theta) \tag{3.1}$$

where t denotes the DG's specific tariff schedule which is applied contingent on the value of θ reported by the FM.[7]

The FM maximizes his/her profit from the domestic sales. Given $\hat{\theta}=\theta$ and t, he maximizes (3.1) with respect to q. The first-order condition is:

$$\pi_q = p + p_q q - c - t = 0 \tag{3.2}$$

And the second-order condition is:

$$\pi_{qq} = 2p_q + p_{qq}q < 0 \tag{3.3}$$

Under the implicit function theorem, (3.2) defines q as a function of t. Also, the effect of changes in t on q can be easily calculated by totally differentiating (3.2). Differentiating (3.2) totally we have the following comparative static effect $\partial q/\partial t$:

$$d\pi_q = \pi_{qq}dq + \pi_{qt}dt = 0,$$

which implies

$$q_t = dq/dt = 1/\pi_{qq} < 0 \quad \text{(by (3.3))} \tag{3.4}$$

The next subsection considers the DG's problem(GP).

3.2.2 The Domestic Government's Problem

When reporting his demand parameter, the FM behaves strategically. However, the Revelation Principle allows us to restrict the design of incentive schemes to mechanisms where truth-telling belongs to the set of optimal strategies of the FM.[8] That is, in order to induce self-selection, the FM's profits with truthful reports have to be at least as large as with misreported demand parameter. An individual rationality constraint has also to be introduced to ensure that the FM is willing to participate. Formally, the incentive compatibility (IC) and the individual rationality (IR) constraints are, respectively, as follows:

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[7] Here we confine our attention to specific tariff regime. However, it is not difficult to characterize the optimal tariff policy under ad valorem regime. See Chapter 2 for symmetric analysis.

$$\pi(\theta : \theta) \geq \pi(\hat{\theta} : \theta), \quad \forall \theta, \hat{\theta} \in [\theta^l, \theta^h] \tag{3.5}$$

$$\pi(\theta : \theta) \geq 0 \quad \forall \theta \in [\theta^l, \theta^h] \tag{3.6}$$

From (3.5), the FM is willing to report truthfully θ when his demand parameter equals θ. (3.6) normalizes the FM's reservation profit to be zero.

The DG's task is to choose an incentive compatible tariff policy so as to maximize expected social welfare subject to the informational constraints above. A tariff policy is said to be "feasible" if it satisfies the IC and the IR constraints for all θ in $\theta \varepsilon [\theta^l, \theta^h]$. Feasible policies imply that the FM will truthfully report demand parameters and export whenever allowed. To sum up, the DG devises its feasible policy to maximize expected social welfare. We now define social welfare as consumer surplus plus tariff revenue.

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[8] The Revelation Principle assures us that there is no loss in generality from considering incentive compatible policies (See Myerson(1979)).

Formally

$$W(t(\theta),\theta) = U(q(t,\theta),\theta) - p(q,\theta)q(t,\theta) + t(\theta)q(t,\theta) \tag{3.7}$$

where $U(q,\theta) = \int_0^q P(\xi,\theta)d\xi$

We assume that W is strictly concave in t. The expected social welfare is now written as

$$W = \int_{\theta_l}^{\theta^h} W(t(\theta),\theta)f(\theta)d\theta \tag{3.8}$$

or equivalently as

$$W = \int_{\theta_l}^{\theta^h} \{U(q,\theta) - cq(t,\theta) - \pi(\theta)\}f(\theta)d\theta \tag{3.9}$$

Through its choice of t, the DG maximizes (3.9) subject to the IR and IC constraints.

3.3 Tariff Policy Under Complete Information

As a benchmark, the complete information case is when the DG shares the FM's knowledge of demand. Formally, the GP is to choose $\{t(\theta)\}$ to maximize the objective function, $W(\theta)$, subject to the constraint that the foreign monopolist earns at its reservation profits.

The optimal tariff policy under full information is characterized by (3.10).

$$\bar{t}_d = (\lambda - 1)\frac{(1-p_t)q}{q_t} \tag{3.10}$$

where $\bar{t}_d$ denotes the optimal tariff under demand uncertainty. Subscript "d" will be used throughout this chapter to distinguish cost from demand uncertainty. As expected, the properties of the solution in the two cases of no cost uncertainty and no demand uncertainty are the same. Note that since we here assume a linear cost function, a constant marginal cost c equals the average cost so that the first term in (2.13) in Chapter 2 disappears. Note also that along with the proof in Chapter 2, $\lambda>1$. If the FM's profit constraint is not binding so that $\lambda=0$, then (3.10) is consistent with Brander and Spencer's(1984a,b) result. The qualitative conclusions are the same as in Chapter 2 and so are omitted.

3.4 Tariff Policy Under Incomplete Information

We now proceed to derive the general solution under asymmetric demand information. As mentioned before, the DG must take into account the feasibility constraints (3.5) and (3.6). Rather than working with (3.5) and (3.6) directly, it is more convenient to use the local representation of feasibility, which we state below in Proposition 3.1.

3.4.1 Incentive Compatible Mechanism

The characterization of the tariff scheme we want to derive is summarized by the following definition.

***Definition*:** A tariff schedule, $t(\theta)$, is *incentive compatible* if it satisfies the IR and IC constraints in the GP.

This defines tariff schedules that constitute feasible solutions to the GP. In what follows we shall also make use of the next assumption which serves to simplify the IC constraints.

Assumption: $p_{q\theta}(q,\theta)=0\ \forall\ \theta\varepsilon[\theta^l,\theta^h]$.[9]

This is a formal representation of the previous assumption that the random variable θ pertains only to the position of the demand curve and not to its shape. This assumption is satisfied by a quasi-linear utility function we have already assumed in the model.

The following two lemmas are instrumental in the proofs of Propositions 3.1 and 3.2, which appear below.

Lemma 3.1: If $p_{q\theta}(q,\theta)=0\ \forall\ \theta\varepsilon[\theta^l,\theta^h]$, then $\pi_{\theta t}(t,\theta)= p_\theta(q,\theta)q_t(t,\theta)\ \forall\ t,\theta$.

Proof: See the Appendix F.

Lemma 3.2: If $p_{q\theta}(q,\theta)=0\ \forall\ \theta\varepsilon[\theta^l,\theta^h]$, then $\pi_{\theta\theta}(t,\theta)= p_\theta(q,\theta)q_t(t,\theta)t_\theta(\theta)\ \forall\ t,\theta$.

Proof: See the Appendix F.

We now establish the properties any incentive compatible tariff function must have.

Proposition 3.1: *A tariff policy {t(θ)} is feasible if and only if it satisfies*:

$$\pi'(\theta)=p_\theta(q,\theta)q(t(\theta),\theta)\ \forall\theta\in[\theta^l,\theta^h], \tag{3.11}$$

$$\pi(\theta^l)\geq 0,\ \textit{and} \tag{3.12}$$

$$t(\theta)\ \textit{is decreasing for all}\ \theta. \tag{3.13}$$

Proof: See the Appendix G.

---

[9] This kind of assumption is commonly imposed in the models with self-selection features, in particular, to describe the preference structure of agents with different tastes. For example, in Lewis and Sappington(1988a) this assumption plays the role of a sufficient condition for the single crossing property(SCP) to hold. It is a well-known result from the Principal-Agent literature that if the agent's utility satisfies a SCP, the first-order and second-order conditions in maximization are globally sufficient (See Guesnerie and Laffont(1984)).

From the Proposition 3.1, we can immediately obtain the following corollary.

Corollary 3.1: With $p_\theta(q,\theta)>0$, $\pi(\theta)$ is a increasing function for all θ.

This corollary subsequently leads two terminal points on the IR constraints in (3.6).

Corollary 3.2: $\pi(\theta^l)=0$, and $\pi(\theta^h)$ is free.

Condition (3.11) and monotonicity of $t(\theta)$, result, respectively, from first-order and second-order incentive compatibility constraints. Eq.(3.11) characterizes the rate at which profit must vary with θ if local incentive compatibility (LIC) constraints are satisfied. Since the profit function $\pi(\theta)$ is a increasing function of the parameter θ for any incentive-compatible policy, the IR constraints will be satisfied if the profit of the lowest demand type θ^l is nonnegative. The continuum of constraints in (3.6) can thus be replaced by the single constraint (3.12). Eq.(3.13) represents the property of the incentive-compatibility tariff scheme. Given a constant marginal cost, the increase in θ shifts the domestic demand curve out to the right. The consumer surplus then increases. Accordingly, the DG will attempt a tariff policy which encourages overstating θ, given the informational asymmetry about demand. The incentive compatible tariff function is decreasing for all θ. Figure 3.1 depicts the relationship between t and θ.

Differentiating (3.1) with respect to the report $\hat{\theta}$ and evaluating it at $\hat{\theta}=\theta$, we obtain

$\pi_1(\theta \mid \theta) = -\ t_\theta(\theta)q(t,\theta)>0$, using (3.13).

Under this incentive compatible tariff policy, therefore, the FM would have an incentive to announce a higher value of θ than actually occurred.

Proposition 3.2: *If the policy $\{t(\theta)\}$ satisfies the LIC constraints, then it also satisfies the IC in (3.5).*

Proof: See the Appendix H.

With this preliminary work done, we now turn to the solution under asymmetric information.

3.4.2 Optimal Tariff Policy Under Incomplete Information

Let's rewrite the GP, using $\pi(\cdot)$ as a state variable.

$$\underset{t}{Max}\int_{\theta^l}^{\theta^h}\{U(q,\theta)-cq(t,\theta)-\pi(\theta)\}dF(\theta)$$

$$\begin{aligned}
&a)\ \pi(\theta^l)\geq 0\\
&b)\ \pi'(\theta)=p_\theta(q(t(\theta),\theta),\theta)q(t(\theta),\theta)\\
&c)\ t_\theta(\theta)<0\\
&d)\ q(t(\theta),\theta)\in \underset{\hat{q}\geq 0}{argmax}\ \pi(t(\hat{\theta}),\theta)
\end{aligned} \tag{3.14}$$

Condition (b) is a local representation of the IC constraints (3.5). Moreover, because $\pi(\theta)$ is increasing function, the IR constraints (3.6) reduces to the boundary condition (a). (c) is a rewriting of the second-order IC condition. We ignore it in the first step and later verify that the solution obtained has the required property. As seen below, however, the solution we derive takes a nonlinear function and thus it is not easy to check the required property. Therefore, we shall present the sufficient condition for (c) to hold. Let's now solve the GP by the maximum principle or the integration by parts (See the Appendix I).

Let $\xi(\theta)$ denote the costate variable associated with $\pi(\theta)$ and $\boldsymbol{H}$ the Hamiltonian associated with the program (3.14).

$$H = \{U(q,\theta) - cq(t,\theta) - \pi(\theta)\}f(\theta) + \xi(\theta)p_{\theta}(q,\theta)q(t,\theta) \tag{3.15}$$

The necessary conditions for an optimum are:[10]

$$\partial H/\partial t = (U'q_t - cq_t)f(\theta) + \xi(\theta)(p_{\theta_q}q_t q + p_{\theta}q_t) = 0 \tag{3.16}$$

$$\partial H/\partial\pi + \xi'(\theta) = 0 \Rightarrow -f(\theta) = -\xi'(\theta) \tag{3.17}$$

$$\partial H/\partial\xi - \pi'(\theta) = 0 \Rightarrow p_{\theta}(q,\theta)q(t,\theta) = \pi'(\theta) \tag{3.18}$$

$$\xi(\theta^l)\pi(\theta^l) = \xi(\theta^h)\pi(\theta^h) = 0 \tag{3.19}$$

With the IR constraints, the transversality conditions(TVC) (3.19) tell us that $\xi(\theta)$ is nonnegative for all θ with $\xi(\theta^h)=0$, and $\xi(\theta^l)\pi(\theta^l)=0$.

Integrating (3.17) from θ to θ^h yields

$$1-F(\theta) = -\ \xi(\theta) \tag{3.20}$$

Maximization of $\pi(\cdot)$ with respect to t gives

$$pq_t - cq_t = (1-p_t)q + tq_t \tag{3.21}$$

---

[10] The maximum principle conditions are, in general, not sufficient, nor do they necessarily yield a unique solution or a global maximum. The conditions are, however, necessary and sufficient if the Hamiltonian is linear in the control variables [Rozonoer's theorem] or if the maximized Hamiltonian is a concave function of the state variables [Mangasarian's theorem]. For the relevant theorems, see Takayama(1974). In view of Mangasarian's theorem, conditions (3.16)-(3.19) constitute a set of necessary and sufficient conditions for an optimum. That is, they completely describe the solution of the problem.

Substituting (3.20) and (3.21) into (3.16) and rearranging we obtain the optimum tariff, denoted by t_d^*, under incomplete information:

$$t_d^* = \frac{(p_t - 1)q}{q_t'} + \frac{(1 - F(\theta))}{f(\theta)} p_\theta(q(t(\theta),\theta),\theta) \tag{3.22}$$

Eq.(3.22) characterizes the optimum incentive compatible tariff schedule of the DG when the hazard rate property is non-increasing for all θ. The second term in (3.22) is an additional tariff; it is adjusted upwards to compensate for the informational asymmetry as reflected by the term $\{1\text{-}F(\theta)\}/f(\theta)$. As described in Chapter 2, the decision of the optimal policy depends heavily upon the effect of the tariff on consumer price, p_t. For most reasonable demand structures price rises by less than the tariff increase: $p_t<1$. Then the adjusted tariff t_d^* exceeds the full-information counterpart, except for the highest-demand level($\theta=\theta^h$). This tariff scheme can be proposed if the DG realizes that a considerable amount of foreign rents is due to asymmetric information about the demand parameters. Under such a trade policy, the DG can recapture some of the monopoly rents the FM is extracting from superior information about demand parameter. On the other hand, it is possible that an increase in the tariff could cause price to rise by more than the tariff increase ($p_t>1$), but only if the domestic demand is very convex. In that case the optimal policy might be an import subsidy. Such a situation occurs when the extent of potential subsidy due to convex demand structure dominates an additional tariff due to information distortion.

t_d^* must now satisfy the constraint (c) in (3.14). As seen in (3.22), the adjusted tariff t_d^* is not linear because of implicit demand function, and thus the problem of checking the required property is somewhat cumbersome. However, since the second term in (3.22), assuming $p_{\theta\theta}<0$, is always non-increasing in θ, the relevant problem reduces to the comparative effect of θ on the first term $(=\bar{t}_{BS})$. $\bar{t}_{BS}$ is just derived from the maximization of W with respect to t under no constraints, given θ. By the same token as in Chapter 2, we can formally obtain the conclusion as Lemma 3.3.

Lemma 3.3: $t_\theta(\theta)<0$, if and only if $W_{t\theta}<0$, with $W_{tt}<0$,

where $W_{t\theta} = p_q q_t q_\theta + (t-p_q q)q_{t\theta}$ and $q_{t\theta} = -(3p_{qq}+p_{qqq}q)q_\theta q_t^2$.

Proof: Analogous to one (the Appendix D) in Chapter 2.

If $q_{t\theta}$ is sufficiently large and negative, then Lemma 3.3 is satisfied. Note that with $q_{t\theta}<0$ an increase in demand parameter θ would magnify the fall in export from a small increase in the tariff rate.

Let's now investigate the policy conclusions at extremes:

$$t_d^*(\theta^h) = \bar{t}_{BS}(\theta^h) = (p_t-1)q/q_t, \quad \text{at } \theta=\theta^h, \text{ and}$$

$$t_d^*(\theta^l) = \bar{t}_{BS}(\theta^l) + [1/f(\theta^l)]p_\theta(\cdot), \quad \text{at } \theta=\theta^l.$$

Brander and Spencer's result is attained at the highest-demand level. This is opposite to the case of cost uncertainty in which Brander and Spencer's result is attained at the lowest cost. This phenomenon is natural by the characteristics of θ in two models. Under demand uncertainty, the DG constructs a tariff policy which discourages understating demand levels. Thus, an additional tariff is imposed by $[1/f(\theta)]p_\theta(\cdot)$ at the lowest demand. With these two extremes and Lemma 3.3 in mind, we now record an immediate policy implications as Propositions 3 and 4 (See Figure 3.2).

Proposition 3.3: *If the tariff policy is continuous in* θ, *and the domestic demand is normal* ($p_t<1$), *the optimal policy is a tariff for all* θ. *The tariff is largest for* θ^l*and smallest for* θ^h.

Proposition 3.4: *With too convex demand structure*($p_t>1$) *the sign of the intervention instrument* $t(\theta)$ *is ambiguous.*

If the domestic demand curve is too convex, there are different policy implications. The tariff can be the optimal instrument only when the FM's report about θ is sufficiently low so that an additional tariff is required. Otherwise the optimal trade policy is an import subsidy rather than a tariff. Furthermore, if the trade policy is continuously contingent on θ, then there exists a θ such that the optimal policy is free trade: i.e., $\exists\ \tilde{\theta}\in[\theta^l,\theta^h]$ s.t. $\bar{t}_{BS}+[(1-F(\theta))/f(\theta)]p_\theta(\cdot)=0$ with $p_t>1$. Comparing with the case of asymmetric cost information, the qualitative implications of optimal trade policy are not altered. Only the magnitude of optimal tariffs differs, depending on the extent of additional tariff which reflects the source and degree of uncertainty about demand or cost.

3.5 Concluding Remarks

We have examined the problem of how the importing country's (here domestic government) tariff is affected by its imperfect knowledge of the local demand. We have seen that a tariff policy without considering informational constraints may not be desired in maximizing social welfare; and that the possibility of the highest social welfare by extracting the higher foreign rents is compromised by incomplete information. In the Chapters 2 and 3, although the DG never observes the true realization of cost or demand parameters, it can construct a scheme such that the FM always report true values. That is, the DG can design a tariff policy which discourages high cost or low demand reports. Under such an incentive-compatible tariff scheme, the optimal tariff must be adjusted upwards to prevent the FM from declaring a low demand and thus it is usually higher levels than full-information counterparts. The gap between an adjusted tariff and full-information counterparts reflects an amount that the DG recaptures some of the monopoly rents the FM is extracting from his private information about cost or domestic demand. The results of this chapter and the previous chapter are summarized in Table 3.1. The policy implications in the presence of incomplete information are insensitive to the source of uncertainty. The difference between t_c^* and t_d^* arises from an additional tariff, which depends on the degree of uncertainty about cost and demand, respectively. Note that the properties of incentive compatible tariff schedules differ in both chapters, depending on the informational parameters under consideration. The incentive compatible tariff function is increasing (decreasing) for all θ under the informational asymmetry about cost (demand). Note also that there is some cost in that market is distorted because of the existence of tariff, but it is clear that, from a purely domestic point of view, protection is likely to be an attractive policy. Because tariffs can transfer foreign rents to the domestic country in the form of tariff revenue. A non-cooperative international equilibrium will involve such tariffs.

We have so far analyzed the model within the separability of uncertainty about costs and demand. However, two-dimension uncertainty (i.e., as when the domestic government is uncertain about both the foreign firm's cost functions and its local demand conditions) may be general in practice. Thus, the comparison of the implications of the optimal tariff when uncertainty is two dimensional with those derived when there is uncertainty only about either cost or demand remains for research. Lewis and Sappington(1988b)'s model, although it is developed within the national regulation and the policy instrument is different, will be useful for this area.

We can also extend our analysis by incorporating the relative weight the government assigns to consumer surplus and tariff revenue. By doing so, we can describe the concrete objective of the domestic government and costs associated with implementing trade policies. Sometimes tariffs are, in practice, one of the few methods available to governments for collecting revenue. This seems to be true, for example, in developing countries where the economic and social structures make it very difficult to collect income taxes and other types of taxes. In this cases, using tariffs for revenue may make some sense. Then the domestic government will assign more weight to the tariff revenues over consumer interests.

Table 3.1. Summary of demand structure and optimal policy

Optimal Policy	Full-information case		Incomplete information case	
Demand Structure	$\lambda=0(\equiv \bar{t}_{BS})$	$\lambda>0(\equiv \bar{t})$	t_c^*	t_d^*
$p_t<1$ (Normal Demand)	Tariff	Subsidy	Tariff	Tariff
$p_t>1$ (Very Convex Demand)	Subsidy	Tariff	Tariff; Subsidy; Free Trade	

Note:

$$\bar{t}_{BS} = \frac{(p_t-1)q}{q_t}, \text{ and}$$

$$\bar{t} = (\lambda-1)\frac{(1-p_t)q}{q_t}, \text{ assuming constant marginal cost.}$$

$$t_c^* = \bar{t}_{BS} + \frac{F(\theta)}{f(\theta)}c_{\theta q}(q,\theta), \text{ and}$$

$$t_d^* = \bar{t}_{BS} + \frac{1-F(\theta)}{f(\theta)}p_\theta(q,\theta).$$

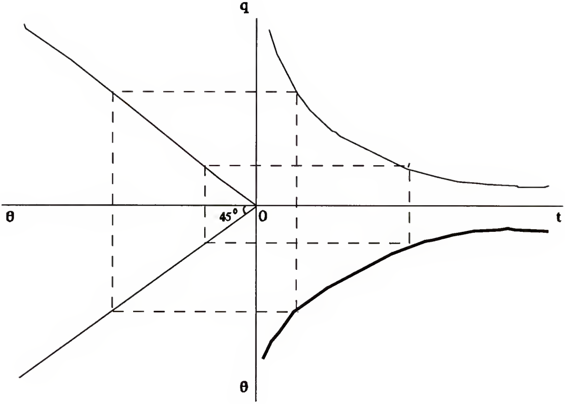
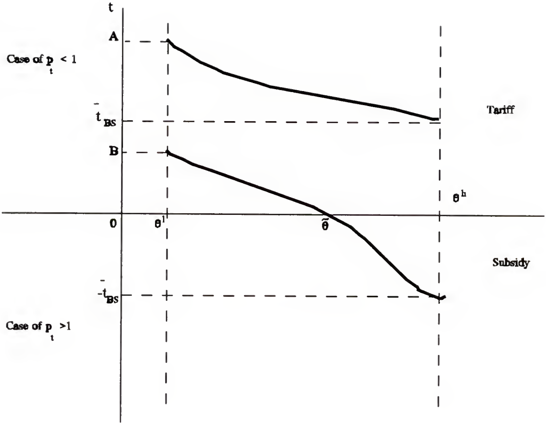


Figure 3.1: Derivation of the Incentive Compatible Tariff Schedule



Note:

A= $\bar{t}_{BS}(\theta^l)+\frac{p_\theta}{f(\theta^l)}$ and

B= $-\bar{t}_{BS}(\theta^l)+\frac{p_\theta}{f(\theta^l)}$ *s.t.* $-\bar{t}_{BS}(\theta^l)<\frac{p_\theta}{f(\theta^l)}$.

Figure 3.2: Demand Structure and Optimal Policies

CHAPTER 4
A DESIGN OF AN OPTIMAL POLICY FOR THE REGULATION OF DUMPING IN THE PRESENCE OF ASYMMETRIC INFORMATION

4.1 Case Study: Korean Semiconductors

Most countries include antidumping duties in their arsenal of trade policies. They have sought to construct antidumping policies that would prevent or mitigate unfair dumping practices. However, antidumping duties usually entail a trade-off between interest groups of the society. An example below illustrates the difficulties of administering such an antidumping laws.

> The standard U.S. use of antidumping laws "suffers from serious shortcomings, especially where high-technology industries are involved," wrote economist Laura Tyson not long before being named President Clinton's senior economic advisor. The Korean semiconductor issue illustrates the problem. Washington did levy punitive tariffs against South Korean semiconductors just as business was getting good. It contends they were being dumped - or sold below home-market prices to grab market share - in the American market, risking great harm to U.S. rivals. So it ordered extra duties to bring Korean prices up to what it says are reasonable rates, leveling the playing field for all concerned. The chips in question are called dynamic random access memories, or DRAMs, a basic component of most computer equipment. The world's electronics industry gobbles them up; the U.S. bought $800 million of Korean chips last year. The Japanese already have 53% of the U.S. DRAM market. According to Micron Technology Inc. of Boise, Idaho, which files an antidumping suit against the Korean DRAMs, the Korean competitors snare 28% of the U.S.market and threaten to take more. So last April, Micron asked the Commerce Department to rule that Korean makers were selling "at less than fair value" under U.S.trade laws, and to slap them with punitive duties. But that doesn't sit well at AST Research Inc. of Irvine, Calif. It uses lots of Korean and other DRAMs to make computers, and likes low-cost parts. AST is particularly upset because Micron also got extra duties applied to imported subassemblies that use Korean chips. That, says AST, could force it to ship more manufacturing overseas to hold down computer prices, endangering 700 U.S. production jobs. The company has warned the Commerce Department and it's

> a concern shared by many DRAM users. "U.S. manufacturing shouldn't be unfairly penalized," the official says............(*Source*: "U.S. Duties on Korean Semiconductors Raise Double-Edged Sword to Dumping," *Wall Street Journal*, February 19, 1993).

Who gaines and who loses from antidumping duties is a question with a subtle answer. As seen in the story above, the truth is hard to find but strong views are everywhere. Supporters of Micron say it's crucial to retain at least some makers of this vital building block of the electronics industry. Others say the U.S. should help users of more-advanced technology and simply buy DRAMs wherever prices are low.

One might then go back to a basic question: How should the importing nation design its antidumping policy to increase the social welfare?

4.2 Introduction

Anti-dumping(A-D) protection has become increasingly common throughout the world. In the six-year period from 1980 to 1986, for instance, over 1200 A-D cases were initiated in Australia, Canada, the European Community, and the United States (Finger (1987)). In the United States alone, according to the *Economist* (November 1991,p.64), between 1980 and 1989 94% of foreign companies accused of dumping were found guilty by the Commerce Department and faced extra duties as a result. By mid-1991 204 products from 40 countries were affected.[1]

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[1] All A-D petitions, of course, are not always subject to penalties. According to Prusa(1993), only some cases of U.S. petitions actually result in dumping duties being levied and the rest is withdrawn after the domestic industry has achieved some type of out-of-court settlement with its foreign rival. This fact is consistent with the argument that many U.S. firms are using A-D laws for reasons other than the original intent of the law (as a defensive statue). The recent U.S. Omnibus Trade Act of 1988 actually encourages petitions for A-D duties, and U.S.(and EC) is proposing changes in GATT rules to make

Dumping is defined in article VI of the GATT as offering a product for sale in export markets at a price below *normal value*.[2] Similarly, U.S. Trade and Tariff Act of 1984 defines dumping as pricing at less than *fair value* in the domestic market.[3] Normal value or fair value usually is defined as the price charged by a firm in its home market.[4] [5] Dumping is also defined as selling for export at prices below cost (See Ethier (1982)).[6] Since it is often difficult to prove that foreign firms charge higher prices to domestic than export customers, the United States and other nations instead often try to calculate a *supposed fair price* based on estimates of foreign production costs.[7] If ethier type of dumping is detected, the foreign firm is penalized. For example, evidence of price

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it easier to apply the A-D law (see Finger(1992). The *Economist*(1988,16) also claimed the European Commission was using the A-D laws "as a tool of European industrial policy."

[2] For a brief introduction to GATT anti-dumping rules, see Finger(1987). For a lengthier treatment see Caine(1981) or Vermulst(1987).

[3] See Caine(1981) or Finger(1992).

[4] In the absence of a domestic price (a home market), the highest comparable price charged in third markets may be used to determine normal or fair value.

[5] The source of this idea goes back to Viner's(1923) seminal exposition on dumping, stating that dumping is price discrimination between countries. See Wares(1977) and Caves and Jones(1985) for a survey and the standard argument.

[6] The cost criterion is more popular, in particular, in trade with centrally planned economies for which data on market prices are usually unavailable or unsatisfactory.

[7] The U.S. Trade Act of 1974 expanded the definition of dumping to include cost-based dumping. In defining below-cost-criterion, average cost is most often specified as the standard. However, the average-cost rule is a special case of a marginal-cost rule. If the investigation aims to determine the minimum of the long-run average-total-cost schedule, the analysis based on the long-run average total cost is equivalent to assuming constant marginal cost. Put it differently, under the assumption of constant returns to scale marginal and average costs are equal.

discrimination across international markets is sufficient (though not necessary) under GATT or U.S.law to establish that dumping has occurred. As a necessary condition for imposing an A-D duties, the GATT A-D Code requires not only that dumping be established by an investigating authority, but also that a domestic industry be materially injured, or face the threat of material injury, and that this injury be caused by imports.[8]

Although the upswing in dumping allegation, defined either as price discrimination in international trade or as sales below costs of production, has so far spawned a voluminous literature, nearly all the studies have been developed in terms of exporting firms: i.e., they have mainly focused on the question of why firms dump in foreign markets.[9] Somewhat surprisingly, there has paid little attention to analyzing an A-D policy in terms of importing country; the reason is perhaps that there is no good economic justification for regarding dumping as particularly harmful except in the cases of predatory intent. Most countries, however, includes A-D duties in their arsenal of trade policies and thus an A-D duty decision is an important area of trade policy. Thus, in my view an important side of the real trading environment is conspicuously absent from the theoretical dumping literature. Recently, several exceptions have appeared in the literature. Leidy and Hoekman (1990) investigate the production response of an exporting firm when faced with the threat of an A-D action. Staiger and Wolak (1992) explore the impact of domestic A-D law in an environment where competitive firms face dumping from a foreign monopoly during periods of a low foreign demand. Webb (1992) examines the effects of an A-D law on price and welfare under Cournot and Stackelberg behaviors. Fischer (1992) and Reitzes (1993) address similar issues in a two-period model. However, they do not analyze the optimal regulatory policy to foreign dumping in terms of an importing nation. Their models are developed only in the framework with the strategic interactions between foreign and domestic firms; the national government is just passive. More rigorous analysis is needed to make the research a more useful guide to the conduct of policy. For example, we would like to know the question of how an importing nation should design its A-D policy to induce social welfare increases. This paper addresses this issue.

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[8] In the U.S., for example, this process is conducted by the Department of Commerce and the U.S. International Trade Commission (USITC). The former determines if dumping has occurred, and the latter determines if the domestic industry has incurred material injury.

[9] For example, see Ethier(1982), Davies and McGuinness(1982), Blair and Cheng(1984), Berhardt(1984), and Hillman and Katz(1986). As underlying reason for the dumping below cost of production, these studies mainly focus on uncertainty. Brander and Krugman(1983) show that the oligopolistic rivalry between firms gives rise to "reciprocal dumping": each firm dumps into other firms' home markets. Pinto(1986) also provides a repeated game version of Brander and Krugman's analysis. More recently, Anderson(1992) argues that anticipation of a VER can motivate dumping. Hartigan(1994) discusses how dumping can be a vehicle for exit inducement by signaling low costs.

In analyzing the problem, we invoke the problem of asymmetric information between the foreign firms and the regulatory authority. Perhaps the most damaging criticism has been raised against the assumption- common to most of trade literature- that the policy-makers have complete information necessary to implement their trade policies, which is unlikely to happen in practice. The regulatory authority generally has less information on the foreign firms' technology than the firms' managers. As a practical matter, many foreign firms accused of dumping complain against such unfair measures or the charged dumping margin and appeal to the GATT or the investigating authority for relief. Their argument is that the importing nations misunderstand their production activities such as home market prices or production costs. In terms of below-cost-criterion, therefore, it seems an essential aspect of the dumping problem that the importing nation does not observe the true cost of the foreign firms. If the importing nation knows exactly the foreign firms' costs, when the dumping exists, it would simply impose A-D duty and readily calculate the dumping margin, based on its precise information. Little effort has been made so far to examine the implications of information asymmetry for strategic trade policy. In this paper, therefore, of central concern is how the DG should design its A-D policy so as to maximize the social welfare subject to the constraints imposed by its lack of knowledge of the FM's costs. This main part is covered in Section 4.5. The novelty of this approach is the insight that the dumping issue is fundamentally a problem of asymmetric information.

According to the match of the domestic and foreign firms, we can analyze the competition game between them. For the comparison with the existing literature, we briefly deal with that game with a quantity-setting Stackelberg model in section 4.4. We then abstract from information problem, focusing just on the effects of an A-D policy on welfare. The negative effect of A-D policy on welfare is shown there. The problem of how an importing nation might regulate dumping to induce welfare increases naturally arises.

The basic descriptions of the model are recorded in next section. Concluding remarks are made in section 4.6.

4.3 Description of the Model

Suppose that the domestic country's market is supplied with a final and slightly differentiated good imported from the foreign firm and also domestically produced by the domestic firm (hereafter DF). Without loss of generality, we assume that the DF produces only for domestic consumption. For simplicity, we also assume that the foreign firm is a monopolistic multinational (FM). Furthermore, the domestic market and other markets are assumed to be segmented (i.e., there are separate demand functions for the domestic and other markets). Under such a circumstance, the intensified competition in the domestic market causes the FM export price to be lower than the prices in other markets. This type of discriminatory pricing is treated as dumping.[10] Then the domestic government (DG) imposes the A-D duty. Each firm faces a symmetric cost structure, which equals $cx+F(\theta y+F^f)$ for the DF(FM). x and y respectively denote the DF's and FM's outputs for the domestic market, while $c(\theta)$ and $F(F^f)$ denote the DF's(FM's) constant marginal and fixed costs, respectively.[11]

The domestic economy consumes a competitive numeraire good m, and two goods x and y. There is an aggregate utility function

$$u = m + U(x,y) \tag{4.1}$$

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[10] This setting is familiar from the existing literature. In many studies, the dumping firm is typically assumed to posses monopoly power in all the relevant markets; competitors, if they exist, act as price-takers.

[11] θ can also be interpreted as the c.i.f. cost of imports, so it includes transport cost. With the assumption of segmented markets, the constant marginal-cost assumption enables us to consider the domestic market in isolation without the added complication of the FM's behavior with respect to its other markets.

which generates inverse demand functions

$$p_1 = \partial U/\partial x \equiv D^1(x,y) \;\; ; \;\; p_2 = \partial U/\partial y \equiv D^2(x,y) \tag{4.2}$$

Under no A-D policy, the profit functions of the two firms are

$$\pi(x,y) = [D^1(x,y) - c]x - F \tag{4.3}$$

$$\pi^f(x,y) = [D^2(x,y) - \theta]y - F^f \tag{4.4}$$

Throughout this chapter superscript "f" denotes variable associated with the foreign firm.

4.4 The Effect of Anti-Dumping Policy and Welfare Analysis

In subsection 4.4.1, we derive the pure-strategy equilibrium as a benchmark solution, under no A-D policy, which arises from two firms' market competition. Subsection 4.4.2 examines the effects of both an A-D policy and the welfare.

4.4.1 Benchmark Solution under No A-D Policy

Each firm's constant marginal and fixed costs are assumed to be common knowledge. In defining the two firms' oligopolistic competition, we assume a quantity-setting Stackelberg model;[12] i.e., the FM (by virtue of its monopoly power in the international market) acts as a Stackelberg leader with the knowledge that the DF will follow Cournot rule.[13]

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[12] The quantity-strategy setting can be justified by the existing conclusion that a quantity strategy dominates a price strategy if the goods are substitutes, not complements (Singh and Vives(1984) and Cheng(1985)).

The DF now takes the level of exports of the FM as given and will produce the corresponding profit-maximizing output, which yields the first-order condition:

$$\pi_x = p_1 + D_1^1 x - c = 0 \tag{4.5}$$

where $D_1{}^1$ is the partial derivatives of D^1. (5) implicitly defines continuous reaction function x = x(y) of the DF. On the other hand, the optimization problem for the FM is to maximize profit subject to the reaction function of the DF as a constraint. The first-order condition is

$$\pi_y^f = p_2 + D_2^2 y - \theta = 0 \tag{4.6}$$

Thus, the optimal export of the FM is determined by MR(y) = θ ≡ MC.

With constant marginal cost, assuming typical domestic demand function (i.e., not convex demand function) the DF's profit function is concave in its own output and so the second-order condition is automatically satisfied:

$$\pi_{xx} = 2D_1^1 + D_{11}^1 x < 0 \tag{4.7}$$

This implies that marginal revenue is declining with respect to its own output.[14] We make further assumption that own marginal revenue is also declining with respect to the FM's output:

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[13] Although the Stackelberg model represents only one specific market structure, it seems a reasonable setting for analysis of dumping. In the international market, one producer can attain dominance over the others, say, by a superior technology, and it will try to use, if any, its information regarding its rivals to extract a larger share of the markets. Brander and Spencer(1981) use the Stackelberg model in the context of entry deterrence.

[14] The local first- and second-order conditions may not be sufficient to ensure a global maximum over the entire feasible range. Because profit is not continuous at zero output,

$$\pi_{xy} = D_2^1 + D_{12}^1 x < 0 \tag{4.8}$$

From the first-order condition for the DF's profit maximization, obtain the slope of DF's reaction function:

$$\frac{dx}{dy} = -\frac{D_2^1 + D_{12}^1 x}{2D_1^1 + D_{11}^1 x} \equiv -\frac{\pi_{xy}}{\pi_{xx}} \tag{4.9}$$

By (4.7) and (4.8) above, (4.9) is negative. In Figure 4.1, the DF's reaction curve is given by **x**(*y*). The FM maximizes its profits at point **S** where its iso-profit contour π_S^f is tangent to the DF's reaction curve. However, it is possible that the FM can earn higher profits than π_S^f by setting its sales to the domestic market at a level which would drive the DF out of business. This monopolistic level of *y* is denoted as y_D in Figure 4.1. It is determined by the intersection of the DF reaction curve and the zero-profits domestic iso-profit contour at **D**. For the Stackelberg equilibrium S to be associated with positive production by the DF it must lie to the south-east of **D**. We assume this to be the case.[15]

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due to fixed costs. Thus we shall here assume that firms obey the first-order conditions provided that profits and output are non-negative at the solution.

[15] The possibility for the co-existence of two firms can be justified in our model which considers a differentiated good. In general, when the FM establishes a monopolistic position in the domestic market by driving the DF out of business, it might be faced with a heavy trade restriction against its exports. Throughout, we assume that the FM chooses a maximum level of exports such that the DF produces products for its home market only. In other context, a tariff may induce the Stackelberg solution. For this discussion, see Brander and Spencer(1981).

4.4.2 Anti-Dumping Policy and Welfare

Let's now examine the effect of the A-D policy. Suppose the FM dumps in the domestic country as a result of unconstrained profit maximization and the DG imposes the A-D duty. This A-D policy affects the profitability of FM in the domestic market. The FM maximizes its profit (4.4) subject to the A-D duties. In this paper, we define an A-D duty as $t = \upsilon - p_2$ s.t. $p_2 < \upsilon$, where υ is the yardstick of dumping judgement.[16] υ can be the price charged by the FM in its home/or other markets (definition of dumping as price discrimination) or cost of production (definition of dumping as below cost). Imports sold for less than this value would automatically penalize with A-D duties. Hereafter we call υ the normal value.

Under A-D duty, the FM's new profits are

$$\pi^f = p_2 y - \theta y - F^f - ty \tag{4.10}$$

For the comparative effects of an A-D duty, we here treat the A-D duty as a tax on the FM, even though they are paid by the importer. Given t, the first-order condition of (4.10) is

$$\pi^f_y = p_2 + D^2_2 y - \theta - t = 0 \tag{4.11}$$

The total differential of the first-order conditions of (4.5) and (4.11) can be written:

$$\begin{bmatrix} \pi_{xx} & \pi_{xy} \\ 0 & \pi^f_{yy} \end{bmatrix} \begin{bmatrix} dx/dt \\ dy/dt \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \tag{4.12}$$

where $\pi^f_{yy} = 2D^2_2 + D^2_{22} y < 0,$ by the second-order condition. Denoting the coefficient matrix on the LHS by Δ, that is positive by the sufficient second-order conditions. Solving this system by using Cramer's rule yields

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[16] Note that the DF cannot affect the dumping margin.

$$\frac{dx}{dt} = \frac{-\pi_{xy}}{\Delta} > 0$$

Similarly

$$\frac{dy}{dt} = \frac{\pi_{xx}}{\Delta} < 0$$

Therefore, we obtain the following result:

Proposition 4.1: *The domestic government's A-D policy increases the domestic firm's output and decreases the foreign monopolist's exports.*

The domestic total consumption will decrease, because the FM's share of the domestic market is relatively large.[17] All of these results are summarized in Table 4.1.

Table 4.1 Effects of anti-dumping policy

x	y	$x+y$	p_1	p_2
↑	↓	↓	↓	↑

We can use the above results to assess the welfare effects arising from enforcing an A-D policy. The social welfare is can be written as the sum of consumer surplus, profits of the DF and government revenue,[18] i.e.,

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[17] In general, the effect of the A-D laws on total consumption is sensitive to the each firm's market share. For more detail, see Fischer(1992) and Reitzes(1993).

[18] For simplicity, we assume that the DG assigns the same weight to consumer surplus, profits of the DF and government revenue.

$$\begin{aligned} W &= \{U(x,y) - p_1 x - p_2 y\} + \pi + ty \\ &= U(x,y) - p_2 y - cx - F + ty \end{aligned} \tag{4.13}$$

The welfare effect of a small shift of the equilibrium can be written in the form

$$dW = (p_1 - c)dx - yd(p_2 - t) + tdy \tag{4.14}$$

The first term in RHS measures the welfare changes to the domestic market distortion due to the divergence of price from marginal cost (production effect), and the second term measures the welfare impact of the change in the FM's markup on sales (TOT effect), while the third term is on the volume of trade effect. The welfare effects can be investigated by examining the changes in each term in (4.14). From Table 4.1 we observe that the foreign markup increases and the trade volume decreases, with negative effects on welfare, respectively. On the other hand, the effect of the domestic production-distortion term is positive. Since the FM's market share is relatively large, however, the welfare gain resulting from the expansion of domestic output is swamped by the welfare loss resulting from the reduction in foreign exports.[19] [20] Then surplus is transferred from domestic consumers to the FM.

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[19] This is in contrast with the existing results. For example, Webb(1992) showed that under quantity-competition strategy, the A-D law has ambiguous welfare effect. When the probability of A-D enforcement is affected by the size of the dumping margin, Fischer(1992) observed that a commitment to an A-D policy may potentially improve welfare under quantity-competition behavior (However, the necessary conditions for this outcome are not explicitly defined). On the other hand, Reitzes(1993) also showed that imposing an A-D policy improves domestic welfare under quantity-setting behavior, and typically worsens it under price-setting behavior. Note that the sensitiveness of welfare effect to an A-D law depends on the model specifications and the special assumptions about the form of oligopolistic competition.

[20] Eldor and Levin(1990) provides a general discussion of the welfare effects arising from output shifts between domestic and foreign firms.

We have so far examined both the effects of an A-D policy on the firms' outputs and prices and welfare effect in a framework with the strategic reactions between firms. We now turn our attention to the (optimal) regulation game of how the DG have to regulate the foreign dumping to induce welfare increases. With more realistic assumption of incomplete information, this problem is analyzed in next section.

4.5 The Optimal Dumping Regulation Under Asymmetric Information

4.5.1 The Timing of the Game

Since the game we are going to analyze here is not market competition but regulation game, active players are the DG(the regulator) and the FM. The DF is assumed to be strategically passive in the sense that it is not regulated (i.e., not subject to A-D duties).[21] We now deal with the regulation game in the principal-agent context. A key feature of the game is that there is an asymmetric information problem between the DG and the FM. Assume that the marginal cost θ is private information to the FM, and cannot be directly observed by the DG. The fixed cost is still common knowledge. We also need to assume that the FM's profits are not observed, otherwise the value of cost parameters could be directly induced from the observation of profits and output.[22] Under such a situation, the FM may have the incentive to use strategically its private costs to obtain a more favorable price in the domestic market. However, the Revelation Principle allows us to restrict the design of incentive schemes to mechanisms where truth-telling belongs to the set of optimal strategies of the agent (the FM).[23] An individual rationality constraint has also to be introduced to ensure the agent is willing to participate.

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[21] Before A-D duties are imposed, of course, the DF must file an A-D suit against the FM. However, in the context of our model which focuses on the efforts of the DG to regulate *ex ante* the FM's dumping activity, this assumption seems a very reasonable requirement.

[22] With the assumption of the DF being strategically passive, this simple informational structure allows us to focus on asymmetries of information between the DG and the FM,

The timing of the game is as follows: Faced with the information gap, the DG first announces a sophisticatedly designed regulatory policy contingent on the FM's true marginal costs. This is equivalent to assuming that the DG can precommit itself to using a particular A-D mechanism, even though it cannot precommit itself to particular levels of A-D duties. For its profit maximization, the FM then chooses one of the regulated menu by picking θ, given the regulation chosen by the DG. Finally, the export occurs to serve the domestic demand partly at the established price.

4.5.2 Specification of the Model

If the FM exports *y*, the DF's optimal output would be x^*=x(*y*), depending on its reaction function. Formally this can be defined as

$$x^* \in \underset{x}{\mathbf{argmax}}\ \pi(x,y)$$

Let the DG's uncertainty about θ be represented by a density function *f*(θ) on the

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ruling out asymmetries of information across firms.

[23] For a relevant literature, see Myerson(1979), Dasgupta, Hammond and Maskin(1979) and Harris and Townsend(1981).

support $[\theta_0,\theta_1]$. For simplicity, we assume that the cumulative distribution function $F(\theta)$ satisfies the monotone hazard rate property: $d(F(\theta)/f(\theta))/d\theta>0$.[24]

For analytical convenience, we also make a restriction on the value of υ. υ is now assumed to be calculated based on estimates of the most efficient foreign production costs. Let $\underline{\theta}$ be the marginal cost of the world's most efficient producer and it be observed by the DG. In U.S. A-D laws, $\underline{\theta}$ is called a reference price.[25]

Lemma 4.1: $\upsilon=\underline{\theta}-\beta$, where $\beta=(p_1-c)\dfrac{dx^*}{dy}$. [26] [27]

Proof: See the Appendix J.

Let's here call υ be a *supposed fair price*. Lemma 4.1 then implies that in the case of the Stackelberg-type economy, the supposed fair price to judge dumping must be set at the higher level than the reference price $\underline{\theta}$. For a predatory dumping range, assume that $\theta_0<\underline{\theta}$, so that $0<\theta_0<\underline{\theta}<\upsilon\leq\theta_1<\infty$. For simplicity, assume also that $\underline{\theta}=\theta$ under full information.

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[24] This property is well satisfied in frequently used distribution such as the uniform, normal, exponential, etc.

[25] The reference price system (or called Trigger Price Mechanism), in the history of U.S. A-D laws, appeared in the U.S. steel industry as an alternative of *fair-value* or *constructed-value* rule. For a lengthier discussion, see Eichengreen and van der Ven(1985).

[26] If we assume the Cournot strategy, then υ would be equal to $\underline{\theta}$. This concept is then consistent with the standard definition of dumping as below cost; i.e., the definition in the reference price system.

[27] That is, ß is the DF's (negative) marginal profit with respect to an import.

We assume that letting $p_2(x(y),y(\theta)) \equiv p_2(\theta)$, the FM behaves strategically by reporting the lower θ so that $p_2(\hat{\theta}) \leq \upsilon$, where $\hat{\theta}$ denotes the cost reported by FM to the DG (throughout this section).[28] We also assume that if the FM reports the true marginal cost, then $\theta = \underline{\theta}$, so that it could no longer be accused of dumping goods in the domestic market.

We model the A-D scheme as follows:

$$t(\hat{\theta}) = h(p_2(\hat{\theta}) - \upsilon) \quad s.t.\ p_2 < \upsilon \tag{4.15}$$

where $h(\cdot)$ represents the partially-offsetting A-D duties with $h_{p_2}(\cdot) < 0$, $h_{p_2 p_2}(\cdot) > 0$, and $h(0)=0$.[29] The A-D-duty restriction now encourages the FM to report high values of θ, whenever this is true (A more rigorous proof is shown in Corollary below). The higher $\hat{\theta}$, the closer to the zero the A-D duties. The penalty schedule is described in Figure 4.2.

The expected profit of the risk-neutral FM, when it reports $\hat{\theta}$ while its true type is θ, is defined as

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[28] As mentioned before, note that the FM will not drive completely the DF out of business, so that the Stackelberg equilibrium is always associated with positive production by the DF. In other context, however, the FM may also induce exit by the DF through acting like a low cost competitor, irrespective of its actual costs. This is a sort of predatory dumping. See Hartigan(1994). For various motives for (below-cost) dumping, see Wares(1977), Chapter 1.

[29] This incentive-compatible A-D policy is self-initiated in the sense that the government can take speedier action for itself, based on the FM's report. According to the history of U.S.A-D laws, reference price system was the self-initiated A-D policy. It was introduced to facilitate rapid initiation of steel dumping complaints. In the months following the reference price system's adoption in 1978, America steel firms were empirically operating at some 90% of their capacity, above the 80% rates prior to the enactment of reference prices. See Carbaugh(1980) p.133.

$$\pi^f(\hat{\theta} : \theta) = p_2(\hat{\theta})y(\hat{\theta}) - \theta y(\hat{\theta}) - F^f - t(\hat{\theta})y(\hat{\theta}) + S(\hat{\theta}) \tag{4.16}$$

where $S(\hat{\theta})$ represents a monetary transfer from the domestic country to the FM depending on the reported type, $\hat{\theta}$.

To guarantee that the foreign firm has no incentive to misrepresent its cost, we must have incentive compatibility (IC) constraint:

$$\pi^f(\theta) \equiv \pi^f(\theta : \theta) \geq \pi^f(\hat{\theta} : \theta), \qquad \forall\ \theta, \hat{\theta} \in [\theta_0, \theta_1] \tag{4.17}$$

Furthermore, it is realistic to assume that the DG cannot force the FM to sell unless it is ensured of a positive profit. That is, the FM earns at least its opportunity profit. So the regulatory policy must also satisfy the individual rationality (IR) constraint:

$$\pi^f(\theta) \geq 0, \qquad \forall\ \theta \in [\theta_0, \theta_1] \tag{4.18}$$

The DG regulates the dumping by setting an export price, $p_2(\hat{\theta})$ indirectly (by choosing an export level), and a monetary transfer, $S(\hat{\theta})$, in order to maximize social welfare. When the foreign firm reports $\hat{\theta}$, it is actually picking a particular item from the regulated menu.

A regulatory policy is *feasible* if it satisfies (4.17) and (4.18) for all θ in $[\theta_0, \theta_1]$. Feasible policies induce the FM to submit true cost reports and export whenever allowed.

The social welfare function of the DG is defined as (4.13). The government's problem (GP) is formally the following:

$$\underset{y,S}{Max}\, W = \int_{\theta_0}^{\theta_1} \{[U(x^*(y),y(\theta)) - p_2(\theta)y(\theta) - S(\theta)] - cx^*(y) - F + t(\theta)y(\theta)\} dF(\theta)$$

$$= \int_{\theta_0}^{\theta_1} \{U(x^*(y),y(\theta)) - \pi^f(\theta) - \theta y(\theta) - cx^*(y) - (F+F^f)\} f(\theta) d\theta \tag{4.19}$$

subject to:

$$a)\ \pi^f(\theta : \theta) \geq 0, \quad \forall\ \theta \in [\theta_0, \theta_1]$$

$$b)\ \pi^f(\theta : \theta) \geq \pi^f(\hat{\theta} : \theta), \quad \forall\ \theta, \hat{\theta} \in [\theta_o, \theta_1]$$

$$c)\ x^* \in \underset{x}{\mathbf{argmax}}\ \pi(x(y), y(\theta))$$

where $\pi^f(\hat{\theta} : \theta) = p_2(\hat{\theta})y(\hat{\theta}) - \theta y(\hat{\theta}) - F^f - t(\hat{\theta})y(\hat{\theta}) + S(\hat{\theta}),$

$$t(\hat{\theta}) = h(p_2(\hat{\theta}) - \upsilon) \quad s.t.\ p_2 < \upsilon$$

4.5.3 Derivation of the Optimal Policy

Let's first obtain the benchmark solutions. This case is when both the DG and the FM observe the true realization of θ before the announcement of the policy. Under such a complete information, the DG maximizes its social welfare under the constraint that the FM be willing to participate (to export). Proposition 4.2 describes the solution to this problem.

Proposition 4.2: *When the DG has complete cost information about the FM's costs, the welfare maximizing regulatory scheme consists of a supposed fair pricing, no A-D duty, and zero operating profits for the FM. That is,* $p_2(\theta) = \upsilon$, $t(\theta) = 0$, *and* $\pi^f(\theta) = 0$ i.e. $S(\theta) = F^f + \beta y$.

Proof: See the Appendix K.

Note that this policy is not feasible for the DG when θ is unknown, because it does not satisfy the IC constraints. From the Proposition 4.2, the optimal regulatory price is higher than the marginal cost θ. Also, under incentive-compatible policy and complete information, the FM could no longer be accused of dumping goods in the domestic market. Since the DG is concerned with maximizing the sum of consumer surplus, producer surplus and government revenues, it uses a lump-sum subsidy/tax to induce the supposed fair pricing by the FM and the subsidy/tax drives the FM to zero profits.

Before proceeding to the optimal policy under asymmetric information, it is useful to note the fact that under the policy in Proposition 4.2, the FM has an incentive to overstate its cost.

Suppose that the DG attempted to implement its regulatory policy as follows: $p_2(\hat{\theta}) = \upsilon$ and $S(\hat{\theta}) = F^f + \beta y.$ Given this policy, the export profit of the FM when its reports $\hat{\theta}$ and its true marginal cost is θ, is

$$\pi^f(\hat{\theta} : \theta) = p_2(\hat{\theta})y(\hat{\theta}) - \theta y(\hat{\theta}) - F^f - t(\hat{\theta})y(\hat{\theta}) + S(\hat{\theta})$$

$$= (\hat{\theta} - \theta)y(\hat{\theta})$$

The FM will choose its report $\hat{\theta}$ to satisfy the first-order condition:

$$y(\hat{\theta}) + (\hat{\theta} - \theta)y'(\hat{\theta}) = 0,$$

which implies that $\hat{\theta} > \theta,$ since $y(\theta)$ is a non-increasing in θ (This will be proved in Lemma 4.2 below).

We now proceed to examine the more realistic asymmetric information case, i.e., when the FM has private information about its marginal cost, θ. In order to solve problem

(4.19), we now transform the IR and IC constraints into more tractable forms. The following Lemma 4.2 characterizes incentive compatible mechanisms.

Lemma 4.2: *The IC and IR constraints hold iff*

$$y(\theta) \ \textit{is a non-increasing function of}\ \theta, \tag{4.20}$$

$$\frac{d\pi^f(\theta)}{d\theta} = -y(\theta) \quad \textit{and} \tag{4.21}$$

$$\pi^f(\theta_1) \geq 0 \tag{4.22}$$

Proof: See the Appendix L.

Eqs.(4.21) and (4.20) result, respectively, from first-order and second-order incentive compatibility conditions. Monotonicity of $y(\theta)$ states that when the FM faces higher costs, it will not export more than when it does lower costs. This restriction is very intuitive. Integrating (4.21) yields

$$\pi^f(\theta) = \pi^f(\theta_1) + \int_{s=\theta}^{\theta_1} y(s)ds. \tag{4.23}$$

Eq.(4.23) defines the information rent earned by the FM from its private information since the domestic country must allow the FM to earn positive profits in order to induce it to truthfully reveal its cost. Eq.(4.22) implies that the FM makes at least zero profit even if it reports the highest possible cost. Since the FM's profits vary with the level of exports, the DG can attain the IC policy by controlling y. Remember that the FM's profit depends only on the report cost, not true cost. On the other hand, the DG wants to reward or penalize the FM depending on whether the reported cost is true or not. Then controlling the FM's profit function cannot itself differentiate between these two cases; rather the DG will try to restrict the avenue through which the FM gains by misreporting. Suppose the FM reports its costs are $\tilde{\theta}$ which will be lower than true cost. Then the FM's gain to misreporting θ is $(\tilde{\theta} - \theta)y(\tilde{\theta})$. So controlling y is enough to eliminate the gain to potential misreports.

Along with Lemma 4.2, the following result is immediate.

Corollary: $t'(\cdot) \leq 0$ for almost all θ.

Proof: Differentiating (4.15) with respect to θ yields

$$\frac{dt}{d\theta} = h_{p_2} \frac{\partial p_2}{\partial y} \frac{dy}{d\theta} < 0. \qquad \blacksquare$$

By representing the IC constraints in a differential form, the Lemma 4.2 now allows the formulation of problem (4.19) using standard optimal control theory with control variable $y(\theta)$ and state variable $\pi(\theta)$. Letting $\mu(\theta)$ denote the costate variable, the Hamiltonian for the GP is

$$H = \{U(x^*(y), y(\theta)) - \pi^f(\theta) - \theta y(\theta) - cx^*(y) - (F + F^f)\} f(\theta) - \mu(\theta) y(\theta)$$

The Hamiltonian is concave given our assumptions. Thus the first-order conditions are

$$H_y = (p_1 \frac{dx^*}{dy} + p_2(\theta) - \theta - c\frac{dx^*}{dy}) f(\theta) - \mu(\theta) = 0 \tag{4.24}$$

$$H_{\pi^f} = -f(\theta) = -\mu'(\theta) \tag{4.25}$$

$$H_\mu = -y(\theta) = \pi^{f'}(\theta) \tag{4.26}$$

Solving (4.25) yields

$$\mu(\theta) = \mu(\theta_0) + \int_{\theta_0}^{\theta} f(s)ds = F(\theta)$$

The second equality follows from the transversality condition, which requires $\mu(\theta_0)=0$; i.e., the profit function is only restricted at the upper endpoint, θ_1.

After substituting this condition into (4.24) and rearranging we obtain the following proposition:

Proposition 4.3: *The regulatory policy ($p_2*(\theta),y*(\theta),S*(\theta),t*(\theta)$) given in (4.27)-(4.30) is feasible and maximizes (4.19) among all feasible regulatory policies.*

$$p_2^*(\theta) = \theta - \beta + z(\theta) \tag{4.27}$$

$$y^*(\theta) = p^{-1}(p_2^*(\theta)) \tag{4.28}$$

$$S^*(\theta) = F^f + (t^*(\theta) + \beta - z(\theta))y^*(\theta) + \int_{\theta}^{\theta_1} y^*(s)ds \tag{4.29}$$

$$\begin{aligned} t^*(\theta) &= h(p_2^*(\theta) - \upsilon) \quad s.t.\ p_2^* < \upsilon \\ &= h(\Delta\theta + z(\theta)) \end{aligned} \tag{4.30}$$

where $z(\theta) = \dfrac{F(\theta)}{f(\theta)}$, $\beta = (p_1 - c)\dfrac{dx^*}{dy}$, and $\Delta\theta = \theta - \underline{\theta}$.

The equilibrium mechanism maximizes expected welfare given the prior information of the DG. Eqs.(4.27) and (4.28) define how the DG sets price and the level of imports. The mechanism induces the FM to set the level of exports so that price equals a supposed fair price plus the marginal information rents that must paid to a FM with cost θ in order to induce it to truthfully reveal its costs. This leads to underexport relative to the full information-benchmark level. Then the magnitude of an export distortion is proportional to $F(\theta)$. In order to guarantee that the optimal regulatory price schedule is implementable, the constraint the $p(\theta)$ is non-decreasing in θ must be satisfied (See Lemma 4.2). With the assumption of $d/d\theta(F(\theta)/f(\theta))>0$, this condition can be readily shown by differentiating (4.27) with respect to θ.

Our concern is now why the DG sets the import price above normal price. To understand why, the behavioral incentives of both the DG and the FM must be examined. In general, the real concern about dumping is that low prices by foreign firms displace domestic producers or potential entrants. In our model, therefore, the DG designs *ex ante* its dumping-regulation policy to encourage the FM to admit that it has high costs, whenever this is true. According to (4.23), the FM's profit is a rent to the private information. That rent is higher the greater is the FM's quantity exported. On the other hand, the DG prefers that those rents be as small as possible. As is evident in (4.19), the FM's rents result in a reduction in domestic welfare. The DG can reduce them by increasing the price and thus decreasing quantity. Note, however, that the DG cannot completely eliminate the rents, because they arise from the need to induce the FM to choose the pricing policy designed for it. The gains from reducing the information rents by raising the price, come at the expense of a reduction in consumer surplus. Then a reduction in CS equals to $y_p^*(\theta)p_2^*(\theta)$ and a reduction in expected rents is given by $(\theta-\beta+z(\theta))y_p^*(\theta)$. The optimal trade-off between these two is reflected in the distortion indicated in (4.27) of price from a supposed fair price.

The DG uses the transfer to insure that the FM earns at least zero profit and also to guarantee incentive compatibility. Unlike the complete-information transfer in Proposition 4.2, $S^*(\theta)$ in (4.29) is designed to prevent the FM misrepresenting its costs. Let's investigate some characteristics of the transfer schedule. First, suppose the FM reports high costs like $\theta+\Delta\theta, \Delta\theta>0$. The loss from such a report is approximately $\Delta\theta y^*(\theta+\Delta\theta)$. The sum of these increments is negative and is given in Eq.(4.23). To eliminate this negative rent, then the DG must offer the FM compensation sufficient to negate those rents. This is accomplished by structuring the subsidy function appropriately that includes the information rents. The compensation is reflected in the last term in Eq.(4.29). On the other hand, the FM's revenues due to the private information, $z(\theta)y^*$ must be deducted. Eq.(4.29) also indicates that the DG regulating dumping will have to transfer any an A-D-duty revenues back to the FM. This implies that the optimal regulatory policy has an effect of correcting the pre-existing the A-D tariff distortions. Notice, however, that this regulatory policy does not suggest that all tariff revenues are neutral. Because A-D duties are only applicable to a specific FM under dumping.

We now turn to the A-D scheme, t^*. One of controversies surrounding dumping concerns whether a charged dumping margin is reasonable. Thus, it is useful to understand components of A-D scheme under incomplete information. Under informational asymmetry, A-D duty is a function of the cost differential plus the marginal information rents. In the current context, the A-D scheme induces the lower cost-type FM to reveal its better type. As noted in Corollary before, function $t(\theta)$ is decreasing. When the FM announces the lowest cost θ_0, its export will be associated with normal value pricing since $F(\theta_0)=0$. From Lemma 4.2, this leads to the highest informational rents. However, A-D duties are then the highest, as seen in Eq.(4.30), so that rent gains can be swamped by the highest A-D duty. Thus, the FM optimally trades off some profit in return for reducing the informational rent due to its private information.

Finally, note that the results in Proposition 4.3 can easily extend to ones of the Cournot competition between two firms. It can be carried out by eliminating ß. With ß=0, the Proposition 4.4 is immediate.

Proposition 4.4: *Under the Cournot competition, the regulatory policy is given:*

$$p_2^*(\theta) = \theta + z(\theta) \tag{4.27a}$$

$$y^*(\theta) = p^{-1}(p_2^*(\theta)) \tag{4.28a}$$

$$S^*(\theta) = F^f + (t^*(\theta) - z(\theta))y^*(\theta) + \int_{\theta}^{\theta_1} y^*(s)ds \tag{4.29a}$$

$$\begin{aligned} t^*(\theta) &= h(p_2^*(\theta) - \underline{\theta}) \quad s.t.\ p_2^* < \upsilon \\ &= h(\Delta\theta + z(\theta)) \end{aligned} \tag{4.30a}$$

where $z(\theta) = \dfrac{F(\theta)}{f(\theta)}$, and $\Delta\theta = \theta - \underline{\theta}$.

The qualitative discussions are analogous to the above ones. As in the Proposition 4.3, the incentive compatible policy implies that the DG sets the price greater than the marginal cost because of the informational asymmetry. The DG has to pay the FM a premium in order to encourage truthful reporting. From a quantitative point of view, however, the optimal regulatory price under the Cournot competition is lower than under the Stackelberg competition. Intuitively, under the Stackelberg leader-follower environment, the DG would lower imports from the FM to protect an inferior domestic firm. This is seen commonly in practice as infant-industry protection. More interestingly, the optimal A-D margin is insensitive to the competition mode between firms (Cournot vs. Stackelberg). Eqs.(4.30) and (4.30a) are the same forms and sizes, irrespective of the type of firm competition.

4.6 Concluding Remarks

Most governments have been sought to construct A-D policies that would prevent or mitigate unfair dumping practices. GATT allows their use if the test of material injury is met. Although A-D laws in most countries have a long history, a relevant theoretical literature seems to be very restricted in scope. In particular, there is little discussion on how an importing nation might regulate dumping to induce welfare increases. This paper takes a modest first step towards this issue.

We examined the role of informational asymmetries in designing dumping regulation policy. We first showed that under the Stackelberg setting and complete information, welfare effect of A-D laws is clearly deteriorate. Thus, under the circumstance that the foreign firm can strategically use the private information about its production costs, the optimal regulation problem of how an importing nation might regulate dumping naturally aries. The regulatory mechanism offered in this paper is constructed within a general revelation approach. This mechanism insists that the foreign firm be provided with incentives to truthfully reveal its costs. The main results are (i) the optimal pricing mechanism can be interpreted as a nonlinear pricing schedule. The price schedule is structured so that the foreign firm interprets prices both as punishment and as a potential compensation. For example, the foreign firm by reporting high costs are compensated with high prices, but very high costs reports are by itself punished with low import quotas. Also, A-D scheme serves greatly to discourage unduly low pricing by the foreign firm. This suggests that the attention given to the negative effects of A-D laws was probably misplaced. In sum, the foreign firm would optimally trade off, under the A-D laws, between its profit variations due to informational rents and A-D duties; (ii) under informational asymmetry, the optimal A-D duties is not sensitive to the firms' competition types, the Cournot or Stackelberg types; (iii) the optimal regulatory policy corrects for the pre-existing A-D tariff distortions in that the domestic government transfers any A-D duty revenues back to the foreign firm. This implies that the domestic government must undo the effects of the pre-existing A-D tariff distortions in order to make allocation decisions based on true costs.

The broader insight we draw from this paper is that informational asymmetries play a crucial role in designing appropriate anti-dumping policies. Governments which fail to recognize that they are limited in their information will not achieve their desired objectives. Thus the regulatory governments should be mindful of the foreign firms' informational rents in designing the optimal dumping-regulation policies.

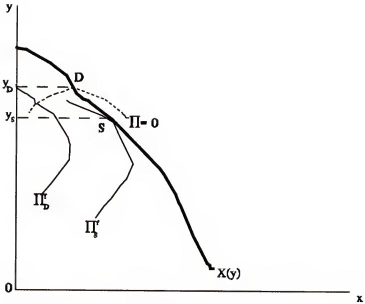

Figure 4.1: Stackelberg Outcome

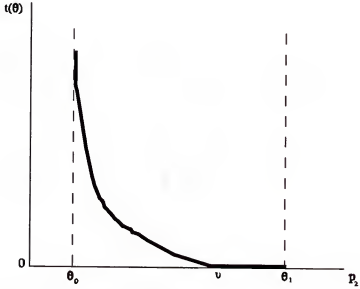

Figure 4.2: The Penalty Schedule

CHAPTER 5
FINAL REMARKS

In this dissertation, we dealt with the problems of strategic and rent extracting tariffs and the optimal policy for the regulation of dumping, when a country faces a foreign firm with market power. Key features of the models are that there is an asymmetric information problem between players. Relatively little attention has so far been paid to examine implications of incomplete information on strategic trade policy. We showed that informational asymmetries play a crucial role in designing appropriate trade policies. The effectiveness of a national government's strategic trade policy is impaired by its limited information about the foreign firm.

While strong results of wide generality are unlikely, we expect that much more can be learned from analyzing informational asymmetries in international markets. Such asymmetries may do much to explain many apparent anomalies in international competitive behavior. In that sense, the literature on strategic trade policy is still in its developing stage. Much work has to be done to extend and generalize the existing literature.

APPENDIX A
DERIVATION OF EQ.(2.13)

θ is publicly revealed so that $\hat{\theta}=\theta$. Thus we drop the integral in the maximand and the IC constraint. From (2.12) the Lagrangian is

$$L(t,\lambda)= u(q) - c(q,\theta) + (\lambda-1)\pi \tag{A1}$$

Differentiating (A1) with respect to t and λ, we obtain the following first-order condition:

$$t\geq 0,\ L_t=u'q_t-c_q q_t+(\lambda-1)(p_t q+pq_t-c_q q_t-q-tq_t)\leq 0,\ tL_t=0 \ \text{,and} \tag{A2}$$

$$\lambda\geq 0,\ L_\lambda=\pi\geq o,\ \lambda\pi=0 \tag{A3}$$

where $p_t=p'q_t$.

Assuming an interior solution(that is, $t>0$) then we obtain $L_t=0$. Under this assumption, we also have $\lambda>0$, which in turn implies $\pi=0$. Then solve (A2) and (A3) to obtain (2.13).

■

On the other hand, we obtain from (A2) that

$$\lambda=\frac{p_t q-q-tq_t}{p_t q+pq_t-c_q q_t-q-tq_t}$$

Now observe the range of λ value.

If $0<\lambda<1$, then $0<(p-c_q)q_t$. This inequality is a contradiction by the necessary condition about the foreign monopolist's profit and Eq.(2.8). Therefore $\lambda>1$. ■

APPENDIX B
PROOF OF LEMMA 2.1

Condition (a) has already been derived in the text (See Eq.(2.15)). The foreign monopolist will truthfully report θ if:

$$\pi_1(\hat{\theta} \vdots \theta) = \left.\frac{\partial \pi(\hat{\theta} \vdots \theta)}{\partial \hat{\theta}}\right|_{\hat{\theta}=\theta} = 0, \quad \forall\, \theta \text{ ; and} \tag{B1}$$

$$\pi_{11}(\hat{\theta} \vdots \theta) \equiv \left.\frac{\partial^2 \pi(\hat{\theta} \vdots \theta)}{\partial \hat{\theta}^2}\right|_{\hat{\theta}=\theta} < 0, \quad \forall\, \theta \text{ (concavity)} \tag{B2}$$

It is useful to find an equivalent condition for (B2). Since (B1) is guaranteed by the revelation principle, we have

$$\begin{aligned}
&\pi_{11}(\theta \vdots \theta) + \pi_{12}(\theta \vdots \theta) = 0 \\
&\pi_{11}(\theta \vdots \theta) = -\pi_{12}(\theta \vdots \theta) \\
&\qquad = -\frac{\partial}{\partial \hat{\theta}}\left[\frac{\partial \pi}{\partial \theta}\right]_{\hat{\theta}=\theta} \\
&\qquad = -\frac{\partial}{\partial \hat{\theta}}\left[-c_\theta(q(\hat{\theta},t),\theta)\right]_{\hat{\theta}=\theta} \\
&\qquad = c_{\theta q}(\cdot)\, q_\theta(\cdot)
\end{aligned} \tag{B3}$$

Since $c_{\theta q}(\cdot)$ which is equivalent to $c_{q\theta}(\cdot)$ through Young's theorem is positive (by assumption (A.2)), (B2) holds if and only if $q_\theta < 0$. ■

Or equivalently, Lemma 2.1 can be proved through the standard proofs presented in Baron and Besanko(1984) or Guesnerie and Laffont(1984). We first prove that IC implies (a) and (b).

Eq.(2.5) can be rewritten as

$$\pi(\hat{\theta} : \theta) = \pi(\hat{\theta} : \hat{\theta}) + c(q(\hat{\theta},t),\hat{\theta}) - c(q(\hat{\theta},t),\theta) \tag{B1.1}$$

Using (B1.1), the IC constraint that guarantees that a foreign monopolist with parameter θ will not report that its parameter is $\hat{\theta}$ may be written as

$$\pi(\theta : \theta) \geq \pi(\hat{\theta} : \theta) = \pi(\hat{\theta},t : \hat{\theta}) + c(q(\hat{\theta},t),\hat{\theta}) - c(q(\hat{\theta},t),\theta) \tag{B1.2}$$

which implies that

$$\pi(\theta : \theta) - \pi(\hat{\theta} : \hat{\theta}) \geq c(q(\hat{\theta},t),\hat{\theta}) - c(q(\hat{\theta},t),\theta) \tag{B1.3}$$

The IC constraint that guarantees that the monopolist with parameter $\hat{\theta}$ will not report that its parameter is θ can be written by reversing the roles of $\hat{\theta}$ and θ in (B1.2).

$$\pi(\theta : \theta) - \pi(\hat{\theta} : \hat{\theta}) \leq c(q(\theta,t),\hat{\theta}) - c(q(\theta,t),\theta) \tag{B1.4}$$

Combining (B1.3) and (B1.4) yields for all θ and $\hat{\theta}$:

$$c(q(\theta,t),\hat{\theta}) - c(q(\theta,t),\theta) \geq \pi(\theta : \theta) - \pi(\hat{\theta} : \hat{\theta}) \geq c(q(\hat{\theta},t),\hat{\theta}) - c(q(\hat{\theta},t),\theta) \tag{B1.5}$$

Convexity of c implies that $q(\theta)$ is nonincreasing.

Dividing (B1.5) by $(\hat{\theta} - \theta)$ (where $\hat{\theta} > \theta$) and taking the limit as $\hat{\theta} \to \theta$ yield

$$\frac{d\pi(\theta)}{d\theta} = -c_{\theta}(q(\theta,t),\theta) \text{ for almost all } \theta \tag{B1.6}$$

which is the same as (2.15).

Integrating (B1.6) from θ to θ_1 yields

$$\pi(\theta) = \pi(\theta_1) + \int_{\theta}^{\theta_1} c_\theta(q(\tilde{\theta},t),\tilde{\theta})d\tilde{\theta} \tag{B1.7}$$

Conversely, to prove sufficiency we show that IC is implied by (a) and (b). So, conversely consider the foreign monopolist's reporting decision. Substituting for $\pi(\hat{\theta} \vdots \hat{\theta})$ from (B1.7) to (B1.1) yields

$$\pi(\hat{\theta} \vdots \theta) = \pi(\theta_1) + \int_{\hat{\theta}}^{\theta_1} c_\theta(q(\tilde{\theta},t),\tilde{\theta})d\tilde{\theta} + c(q(\hat{\theta},t),\hat{\theta}) - c(q(\hat{\theta},t),\theta) \tag{B1.8}$$

Substituting $\pi(\theta_1)$ from (B1.7) for $\theta < \hat{\theta}$ yields

$$\pi(\hat{\theta} \vdots \theta) = \pi(\theta) - \int_{\theta}^{\hat{\theta}} c_\theta(q(\tilde{\theta},t),\tilde{\theta})d\tilde{\theta} + c(q(\hat{\theta},t),\hat{\theta}) - c(q(\hat{\theta},t),\theta) \tag{B1.9}$$

Combining terms yields

$$\pi(\hat{\theta} \vdots \theta) = \pi(\theta) - \int_{\theta}^{\hat{\theta}} [c_\theta(q(\tilde{\theta},t),\tilde{\theta}) - c_\theta(q(\hat{\theta},t),\hat{\theta})]d\tilde{\theta} \tag{B1.10}$$

Consequently, $\pi(\theta) \geq \pi(\hat{\theta} \vdots \theta), \forall\ \hat{\theta},\theta,$ is satisfied if the integral in (B1.10) is non-negative. That integral is non-negative, because $q(\theta)$ is nonincreasing. Thus the IC constraints are satisfied locally. Note that if $\theta > \hat{\theta},$ the integrand is nonpositive but the direction of the integral is reversed, so the integral is nonnegative. ■

APPENDIX C
DERIVATION OF EQ.(2.23)

Note that in the reformulated (2.12a) IC and IR were already incorporated into constraint (b). Rewriting the objective function, we have:

$$Max \int_{\theta_0}^{\theta_1} \{u(q(\theta,t)) - c(q(\theta,t),\theta) - \int_{\theta}^{\theta_1} c_\theta(q,\tilde{\theta})d\tilde{\theta}\} f(\theta)d\theta \qquad \text{(C1)}$$

By using integration by parts we get:

$$\begin{aligned} \int_{\theta_0}^{\theta_1} \pi(\theta)f(\theta)d\theta &= \int_{\theta_0}^{\theta_1}\int_{\theta}^{\theta_1} c_\theta(q,\tilde{\theta})d\tilde{\theta} f(\theta)d\theta \\ &= \int_{\theta}^{\theta_1} c_\theta(q,\tilde{\theta})d\tilde{\theta}F(\theta)\Big|_{\theta_0}^{\theta_1} - \int_{\theta_0}^{\theta_1} F(\theta)(-c_\theta(q,\theta))d\theta \qquad \text{(C2)} \\ &= \int_{\theta_0}^{\theta_1} c_\theta(q,\theta)F(\theta)d\theta \end{aligned}$$

Since the first term in the second line is zero.

Substituting for (C2) in (C1) the optimization is transformed to the following:

$$Max \int_{\theta_0}^{\theta_1} \{u(q(\theta,t)) - c(q(\theta,t),\theta) - c_\theta(q,\theta)\frac{F(\theta)}{f(\theta)}\} f(\theta)d\theta \qquad \text{(C3)}$$

Taking pointwise optimization at a particular value of θ yields

$$u'q_t - c_q q_t - c_{\theta q}(q,\theta)q_t\frac{F(\theta)}{f(\theta)} = 0 \qquad \text{(C4)}$$

On the other hand, we know from the first-order condition of Eq.(2.5) with respect to an equilibrium value t that

$$pq_t - c_q q_t = tq_t + (1 - p_t)q \tag{C5}$$

Substituting for(C5) in (C4) and dividing by q_t we obtain the optimum tariff which is the same as Eq.(2.23). ■

APPENDIX D
DERIVATION OF EQ.(2.27)

The principal steps in the derivation of expression (2.27) follow.

The partial derivative of (2.25) with respect to θ is

$$W_{t\theta} = q_\theta - p_t q_\theta - p_{t\theta} q + t q_{t\theta} \tag{D1}$$

Note that $p_t=p'q_t$ and $p_{t\theta}=p''q_\theta q_t + p'q_{t\theta}$. Substituting for them in (D1), we have:

$$W_{t\theta} = q_t q_\theta (1/q_t - p' - p''q) + (t - p'q)q_{t\theta} \tag{D2}$$

Recalling that $q_t=1/\pi_{qq}$ from (2.8), where $\pi_{qq}=2p'+p''q-c_{qq}$, and canceling terms, (D2) reduces to

$$W_{t\theta} = q_t q_\theta (p' - c_{qq}) + (t - p'q)q_{t\theta} \tag{D3}$$

In equilibrium, $t-p'q = p-c_q$. Substituting for it in (D3) we obtain (2.27) of the text.

On the other hand, $q_{t\theta}=-(d\pi_{qq}/d\theta)/(\pi_{qq})^2=-(q_t)^2(d\pi_{qq}/d\theta)$. Noting again that $\pi_{qq}=2p'+p''q-c_{qq}$,

$$\frac{d\pi_{qq}}{d\theta} = 3p''q_\theta + p'''q_\theta q - \frac{dc_{qq}}{d\theta}$$

Thus $q_{t\theta} = -q_t^2[(3p''+p'''q)q_\theta - \frac{dc_{qq}}{d\theta}]$

which is the same expression as in the text. ■

APPENDIX E
DERIVATION OF EQ.(2.35)

The GP is as follows:

$$\underset{\tau}{Max}\ W=\int_{\theta_0}^{\theta_1}\{u(q(\theta,\tau))-c(q,\theta)-\pi(\theta)\}dF(\theta)$$

s.t.

$a)\,\pi(\theta)\geq 0$

$b)\,\pi'(\theta)=-c_{\theta}(q(\theta,\tau),\theta)$

$c)\,q_{\theta}(\cdot)\leq 0\Rightarrow \tau_{\theta}>0$

As in the specific case, denoting the costate variable by $\mu(\theta)$, the Hamiltonian H is

$$H=\{u(q)-c(q,\theta)-\pi(\theta)\}f(\theta)-\mu(\theta)c_{\theta}(q,\theta) \tag{E1}$$

The optimal conditions are:

$$H_{\tau}\ =\ (u'q_{\tau}-c_{q}q_{\tau})f(\theta)-\mu(\theta)c_{\theta q}(q,\theta)q_{\tau}=0 \tag{E2}$$

$$H_{\pi}+\mu'(\theta)=0\rightarrow -f(\theta)\ =\ -\mu'(\theta) \tag{E3}$$

$$H_{\mu}-\pi'(\theta)=0\rightarrow -c_{\theta}(q,\theta)=\pi'(\theta) \tag{E4}$$

$$\mu(\theta_0)\pi(\theta_0)=\mu(\theta_1)\pi(\theta_1)=0\ \ \text{(TVC)} \tag{E5}$$

Integrating (E3) from θ_0 to θ_1 and using Lemma 2.4 we get

$$\mu(\theta) = \boldsymbol{F}(\theta) \tag{E6}$$

On the other hand, the following expression is satisfied at an equilibrium τ:

$$pq_\tau - c_q q_\tau = (p^f - p_\tau)q + (p^f_\tau q + p^f q_\tau)\tau \tag{E7}$$

After substituting (E6) and (E7) in (E2) and rearranging we can get (2.35). Eq.(2.36) can also be obtained by applying the same technique. ■

APPENDIX F
PROOFS OF LEMMA 3.1 and 3.2

The proofs of Lemma 3.1 and 3.2 follow from straightforward differentiation of $\pi(\cdot)$.

$$\pi(\hat{\theta} : \theta) = p(q(t(\hat{\theta}),\theta),\theta)q(t(\hat{\theta}),\theta) - cq(t(\hat{\theta}),\theta)$$
$$- t(\hat{\theta})q(t(\hat{\theta}),\theta)$$

Assuming differentiability (See Guesnerie and Laffont(1984) for a proof of this), the LIC constraints require

$$\pi_1(\hat{\theta} : \theta)\Big|_{\hat{\theta}=\theta} = \frac{\partial \pi(\hat{\theta} : \theta)}{\partial \hat{\theta}}\Bigg|_{\hat{\theta}=\theta} = 0 \tag{F1}$$

Then, defining $\pi(\theta) \equiv \pi(\theta : \theta)\ \forall\, \theta \in [\theta^l, \theta^h]$,

$$\pi'(\theta) = \pi_1(\theta : \theta) + \pi_2(\theta : \theta)$$
$$= (p + p_q q - c - t)q_\theta + p_\theta q$$

From the first-order condition of the profit maximization, the bracketed term is zero.

Thus, $\pi'(\theta) = p_\theta(q,\theta)q(t(\theta),\theta)\ \ \forall\, \theta \in [\theta^l, \theta^h]$ (F2)

Differentiating (F1) with respect to t yields

$$\pi_{\theta t}(\theta,t) = p_{q\theta}(\cdot)q_t(\cdot)q(\cdot) + p_\theta(\cdot)q_t(\cdot)$$

With the assumption of $p_{q\theta}(\cdot)=0$, Lemma 1 is immediately obtained.

Also, differentiating (F1) with respect to the announcement $\hat{\theta}$ and evaluating it at $\hat{\theta}=\theta$, we obtain Lemma 3.2, using $p_{q\theta}(\cdot)=0$. ■

APPENDIX G
PROOF OF PROPOSITION 3.1

Constraint (3.11) is a necessary condition for the IC constraints to hold. (F2) in the Appendix F leads directly to the result in (3.11). On the other hand, a sufficient condition for the IC constraints in the GP to hold is:

$$\pi_{11}(\hat{\theta}:\theta)=\left.\frac{\partial^2\pi(\hat{\theta}:\theta)}{\partial\hat{\theta}^2}\right|_{\hat{\theta}=\theta}<0$$

Since (F1) must hold $\forall\theta$, we must have $d\pi_1(\theta\mid\theta)/d\theta=0$. This relationship reduces to

$$\pi_{11}(\hat{\theta}:\theta)\big|_{\hat{\theta}=\theta}+\pi_{12}(\hat{\theta}:\theta)\big|_{\hat{\theta}=\theta}=0.$$

Therefore,

$$\begin{aligned}\pi_{11}(\hat{\theta}:\theta)\big|_{\hat{\theta}=\theta}&=-\frac{\partial}{\partial\hat{\theta}}\left(\frac{\partial\pi(\hat{\theta}:\theta)}{\partial\theta}\right)_{\hat{\theta}=\theta}\\&=-\frac{\partial}{\partial\hat{\theta}}[(p+p_q q-c-t)q_\theta+p_\theta q]\\&=-(p_{\theta q}q_t t_\theta q+p_\theta q_t t_\theta)\end{aligned}$$

Since $p_\theta>0$, $q_t<0$ and $p_{q\theta}=0$, a sufficient condition for the IC holds if and only if $t_\theta<0$, $\forall\theta\varepsilon[\theta^l,\theta^h]$. ■

APPENDIX H
PROOF OF PROPOSITION 3.2

Consider any two realization of θ, e.g., θ_1, θ_2 $\varepsilon[\theta^l,\theta^h]$ with $\theta_2>\theta_1$. The proof is complete if we can show the following:

$$\pi(\theta_2 \vdots \theta_2) \geq \pi(\theta_1 \vdots \theta_2) \tag{H1}$$

To prove this inequality, observe that the following relationships hold:

$$\pi(\theta_1 \vdots \theta_2) = \pi(\theta_2 \vdots \theta_2) - \int_{\theta_1}^{\theta_2} \pi_{\theta}(\theta \vdots \theta_2) d\theta \tag{H2}$$

$$\pi_{\theta}(\theta \vdots \theta_2) = \int_{\theta}^{\theta_2} \pi_{\theta\tilde{\theta}}(\theta \vdots \tilde{\theta}) d\tilde{\theta} \tag{H3}$$

(H2) is obvious. (H2) follows from the LIC. From Lemma 3.1 and 3.2 we now obtain

$$\pi_{\tilde{\theta}\theta}(\theta \vdots \tilde{\theta}) = \pi_{\tilde{\theta}t}(\cdot) t_{\theta} \tag{H4}$$

Substituting (H3) and (H4) into (H2) yields

$$\pi(\theta_1 \vdots \theta_2) = \pi(\theta_2 \vdots \theta_2) - \int_{\theta_1}^{\theta_2}\int_{\theta}^{\theta_2} \pi_{\tilde{\theta}t}(t(\theta),\tilde{\theta}) t_{\theta}(\theta) d\tilde{\theta} d\theta \tag{H5}$$

Since $\pi_{\tilde{\theta}t}(\cdot)<0$ and $t_\theta(\theta)<0$, (H1) is resulted. The same argument holds for $\theta_1>\theta_2$. ■

APPENNDIX I
DERIVATION OF EQ.(3.22) BY THE INTEGRATION BY PARTS

In the transformed GP (3.14), integrating (b) from θ^l to θ we have

$$\pi(\theta) = \int_{\theta^l}^{\theta} p_\theta(q,\tilde{\theta})q(t,\tilde{\theta})d\tilde{\theta}$$

Hence, $\displaystyle\int_{\theta^l}^{\theta^h} \pi(\theta)f(\theta)d\theta = \int_{\theta^l}^{\theta^h}\int_{\theta^l}^{\theta} p_\theta(q,\tilde{\theta})q(t,\tilde{\theta})d\tilde{\theta}f(\theta)d\theta$

By the integration by parts we obtain

$$\begin{aligned}\int_{\theta^l}^{\theta^h} \pi(\theta)f(\theta)d\theta &= F(\theta)\int_{\theta^l}^{\theta} p_\theta q\, d\tilde{\theta}\Bigg|_{\theta^l}^{\theta^h} - \int_{\theta^l}^{\theta^h} F(\theta)p_\theta q\, d\theta \\ &= \int_{\theta^l}^{\theta^h} (1-F(\theta))p_\theta q\, d\theta\end{aligned} \tag{I1}$$

Since $F(\theta^h)=1$. Substituting (I1) in the maximand, we obtain

$$Max\int_{\theta^l}^{\theta^h} \{\, U(q,\theta) - cq(t,\theta) - \frac{1-F(\theta)}{f(\theta)}p_\theta q\,\}dF(\theta) \tag{I2}$$

The pointwise maximization at a particular value of θ is

$$U'q_t - cq_t - \frac{1-F(\theta)}{f(\theta)}(p_{\theta q}q_t q + p_\theta q_t) = 0 \tag{I3}$$

Substituting (3.21) and $p_{q\theta}=0$ into (I3) and rearranging, we immediately obtain the optimal tariff (3.22). ■

APPENDIX J
PROOF OF LEMMA 4.1

In general, trade restriction policies including an A-D policy entail a trade-off between domestic consumer surplus and domestic firms' profits. Thus, we usually face a commonly-held view: Why do countries have A-D laws at all, since the opportunity to buy goods at a low price would seem to be a good thing? Aside from the economic rationale for the A-D policy, a reasonable fair price to judge the dumping is required. To set the fair price endogenously, we assume that the DG determines the value of υ in direction of maximizing the social welfare. This assumption seems fairly reasonable.

In the context of the model, substituting $t = \upsilon - p_2$ into (4.13) yields

$$W = U(x^*, y) - 2p_2 y - cx^* - F + \upsilon y$$

Let demand for foreign products be perfectly elastic (so price p_2 there is fixed). Differentiating W with respect to y yields

$$\frac{dW}{dy} = (p_1 - c)\frac{dx^*}{dy} - p_2 + \upsilon = 0$$

If the FM is the world's most efficient producer, then $p_2 = \underline{\theta} = MC$. Thus Lemma 1 follows. ■

APPENDIX K
PROOF OF PROPOSITION 4.2

Assuming $\hat{\theta}=\theta$, we can drop the integral in the maximand and the IC constraint.

The Lagrangian function for the problem can be written

$$\mathcal{L} = U(x^*,y) + (\lambda-1)\pi^f(\theta) - \theta y - cx^* - (F+F^f) \tag{K1}$$

where λ is a lagrange multiplier

The program {(4.19) and (4.19a)} is concave and its(interior) maximum is characterized by the first-order conditions (differentiate (K1) with respect to S, y, and λ, respectively):

$$\mathcal{L}_S = \lambda - 1 = 0$$

$$\mathcal{L}_y = p_1\frac{dx^*}{dy} + p_2 + (\lambda-1)[\frac{d\pi^f}{dy}] - \theta - c\frac{dx^*}{dy} = 0 \tag{K2}$$

$$\mathcal{L}_\lambda = \pi^f(\cdot) \geq 0$$

From the second equation, $p_2(\theta) = \theta-(p_1-c)dx^*/dy$. (K3)

By a given assumption $p_2(\theta) = \upsilon$.

Also, Eq.(4.15) yields

$$t = 0 \tag{K4}$$

Finally, substituting (K3) and (K4) into $\pi^f(\theta)$, we get (K5)

$$S(\theta) = F^f+(p_1-c)(dx^*/dy)y. \tag{K5}$$

■

APPENDIX L
PROOF OF LEMMA 4.2

Assume that $\{y(\cdot), S(\cdot)\}$ is incentive compatible. Eq.(4.16) can be rewritten as

$$\pi^f(\hat{\theta} \vdots \theta) \;=\; \pi^f(\hat{\theta}) + (\hat{\theta} - \theta)y(\hat{\theta}) \tag{L1}$$

An IC constraint in (4.17) implies, using (L1):

$$\pi^f(\theta) \geq \pi^f(\hat{\theta} \vdots \theta) \equiv \pi^f(\hat{\theta}) + (\hat{\theta} - \theta)y(\hat{\theta}) \tag{4.17a}$$

which implies that

$$\pi^f(\theta) - \pi^f(\hat{\theta}) \geq (\hat{\theta} - \theta)y(\hat{\theta}) \tag{L2}$$

Reversing the roles of θ and $\hat{\theta}$ in (L1) and (4.17a) implies that

$$\pi^f(\theta) - \pi^f(\hat{\theta}) \leq (\hat{\theta} - \theta)y(\theta) \tag{L3}$$

Combining (L2) and (L3) yields for all θ and $\hat{\theta}$:

$$(\hat{\theta} - \theta)y(\hat{\theta}) \leq \pi^f(\theta) - \pi^f(\hat{\theta}) \leq (\hat{\theta} - \theta)y(\theta) \tag{L4}$$

(L4) implies

$$(\hat{\theta} - \theta)y(\hat{\theta}) \leq (\hat{\theta} - \theta)y(\theta), \qquad \forall \theta, \hat{\theta} \in [\theta_0, \theta_1] \tag{L5}$$

If $\hat{\theta} > \theta$, then (L5) requires that $y(\theta) \geq y(\hat{\theta})$. Consequently, y is a non-increasing function of θ.

On the other hand, dividing (L4) by $(\hat{\theta}-\theta)$ for $\hat{\theta}>\theta$, and taking the limit as $\hat{\theta}\to\theta$ yields:

$$\frac{d\pi^f(\theta)}{d\theta} = -y(\theta), \quad \text{for almost all } \theta. \tag{L6}$$

Integrating (L6), to obtain an equivalent local condition on the profit function, yields:

$$\pi^f(\theta) = \pi^f(\theta_1) + \int_{\theta}^{\theta_1} y(\tilde{\theta})d\tilde{\theta}$$

which is the same as (4.23). $\pi(\theta_1)$ is the profit with the highest possible marginal cost. From (L6), we know that $\pi(\theta)$ is a decreasing function of θ for any IC policy. Then, IR constraint in (4.18) will be satisfied if the FM's profit in the highest cost type θ_1 is non-negative. The continuum of IR constraint can thus be replaced by the single constraint:

$\pi(\theta_1) \geq 0$

Hence, necessity is proven.

Conversely, to prove sufficiency we must show that conditions (4.17) and (4.18) are implied by the (4.20)-(4.22). Condition (4.18) follows from (4.21) and (4.22). To prove (4.17), note first that (L1) implies

$$\pi^f(\hat{\theta}:\theta) = \pi^f(\hat{\theta}) + (\hat{\theta}-\theta)y(\hat{\theta})$$

and (4.21) for $\theta=\hat{\theta}$ can be rewritten:

$$\pi^f(\hat{\theta}) = \pi^f(\theta_1) + \int_{\hat{\theta}}^{\theta_1} y(\tilde{\theta})d\tilde{\theta}$$

Thus combining two expressions yields:

$$\pi^f(\hat{\theta} : \theta) = \pi^f(\theta_1) + \int_{\hat{\theta}}^{\theta_1} y(\tilde{\theta})d\tilde{\theta} + (\hat{\theta} - \theta)y(\hat{\theta}) \tag{L7}$$

Substituting $\pi(\theta_1)$ in (4.21) into (L7) yields

$$\pi^f(\hat{\theta} : \theta) = \pi^f(\theta) - \int_{\theta}^{\hat{\theta}} y(\tilde{\theta})d\tilde{\theta} + (\hat{\theta} - \theta)y(\hat{\theta})$$

Combining terms yields:

$$\pi^f(\hat{\theta} : \theta) = \pi^f(\theta) - \int_{\theta}^{\hat{\theta}} [y(\tilde{\theta}) - y(\hat{\theta})]d\tilde{\theta} \tag{L8}$$

Consequently, (4.17) for all θ and $\hat{\theta}$, is satisfied if the integral in (L8) is non-negative. That integral is, however, non-negative, because $y(\theta)$ is non-increasing. Note that if $\hat{\theta} > \theta$, the integrand is non-negative, and if $\hat{\theta} < \theta$, the integrand is non-positive but the direction of the integral is reversed, so the integral is non-negative. ■

Lemma 4.1 can also be derived directly from the envelope theorem. Assuming differentiability, the first-order condition for maximizing over $\hat{\theta}$ in Eq.(4.16) is

$$\left.\frac{\partial \pi^f(\hat{\theta} : \theta)}{\partial \hat{\theta}}\right|_{\hat{\theta}=\theta} = 0, \quad \forall\ \theta \in [\theta_o, \theta_1] \text{ (Local Incentive Compatibility)}$$

Thus, the total derivative is

$$\frac{d\pi^f(\theta)}{d\theta} = \frac{\partial\pi^f(\hat\theta : \theta)}{\partial\hat\theta}\frac{d\hat\theta}{d\theta}\bigg|_{\hat\theta=\theta} + \frac{\partial\pi^f(\hat\theta : \theta)}{\partial\theta}\frac{d\theta}{d\theta}\bigg|_{\hat\theta=\theta}$$

$$= \frac{\partial\pi^f(\hat\theta : \theta)}{\partial\theta}\bigg|_{\hat\theta=\theta}$$

$$= -y(\theta)$$

which is the same as Eq.(4.21), integrating from θ to θ_1.

On the other hand, LIC holds for every θ $\varepsilon[\theta_0,\theta_1]$. Thus, defining $\pi_1^f(\theta) \equiv \frac{\partial\pi^f(\hat\theta : \theta)}{\partial\hat\theta}\Big|_{\hat\theta=\theta}$ we have

$$\pi_{11}^f(\theta : \theta)\frac{d\hat\theta}{d\theta} + \pi_{12}^f(\theta : \theta)\frac{d\theta}{d\theta} = 0$$

Accordingly $\pi_{11}^f(\theta : \theta) = -\pi_{12}^f(\theta : \theta)$.

$$= -\frac{\partial}{\partial\hat\theta}\left(\frac{\partial\pi^f(\hat\theta : \theta)}{\partial\hat\theta}\right)_{\hat\theta=\theta}$$

$$= -\frac{\partial}{\partial\hat\theta}(-y(\hat\theta))_{\hat\theta=\theta}$$

$$= y_\theta(\theta)$$

By the second-order condition for maximization, this is negative, which in turn implies that the function $y(\theta)$ is non-increasing. ■

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I certify that I have read this study and that in my opinion it confirms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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